MISSION SYSTEMS

Mission Operations Support Plan (MOSP) for the EARTH OBSERVING SYSTEM TERRA MISSION

DECEMBER 1999

NASA

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

Mission Operations Support Plan (MOSP)
for the
EOS TERRA MISSION

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EOS TERRA Mission

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Preface

The purpose of the Goddard Space Flight Center (GSFC) Flight Projects Directorate (FPD), Code 400, Mission Operations Support Plan (MOSP) for the TERRA mission is to provide mission-unique operational procedures and configuration information required by the FPD and other elements. Standard procedures for intra- and inter-element operations and for EOS Operations Center (EOC) interface activities are defined in reference documents contained in the appendix of this MOSP. Where referenced conflicts exist with other documents, the provisions of this document take precedence.

The configuration information contained in this document includes both automated data base contents and manual configuration instructions as appropriate to the element. In providing this mission-unique information, this document forms the point of control for automated data bases in use in the FPD and for the manual configurations as required.

This issue of the document has been developed to accommodate the needs of normal FPD. When appropriate, this document will be upgraded by revision or Documentation Change Notice (DCN) phase information.

Between revision or reissue cycles, all changes to this document, and thus to data bases, manual configurations, and mission-unique procedures contained herein, will be made by DCN.

Questions from FPD elements, or project organizations concerning the information contained in this document should be transmitted to the EOC.

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Section 1.0 Introduction

1.1 Purpose

This Mission Operations Support Plan (MOSP) describes mission operations for the TERRA spacecraft, including how EOS Data and Information System (EOSDIS) mission systems will be operated. EOSDIS Mission Systems include systems associated with the command, control, and monitoring of the spacecraft and Level 0 processing and archiving of spacecraft data.

1.2 Scope

This plan summarizes the Flight and EOSDIS Projects, and Earth Observing (EOS) program facilities relative to mission operations support for the TERRA mission. Detailed descriptions of real-time operations, on-orbit spacecraft activity, schedules, and other flight-related operations are included in other EOS operations documents.

This MOSP describes the Flight Operation Team (FOT) functional roles, responsibilities, and interfaces. Required element support and operations planning are described to address mission requirements. EOS program facilities and interfaces with associated national and international elements are addressed in the context of mission operations support.

1.3 Project Structure

The TERRA Flight Project, Code 421 is responsible for developing the TERRA spacecraft. The ESDIS Project is responsible for developing and operating the Earth Observing System Data and Information System (EOSDIS), which performs the ground and spacecraft data processing. The ESDIS Project operates the EOSDIS, which includes the EOS Operations Center (EOC) where mission operations for all EOS spacecraft will be conducted.

1.4 Mission Development and Management Roles

The ESDIS and Flight Projects manage spacecraft and ground system development and operational activities. The respective roles and responsibilities of the Flight Projects and the ESDIS Project are documented in Interproject Agreements (IPAs). For example, flight operation support for TERRA is documented in an IPA between the TERRA Project and the ESDIS Project.

The ESDIS Project develops, integrates, and tests EOSDIS, including the EOS Mission Operations System (EMOS) providing ground system support for command and control of the spacecraft. The EMOS and Flight Operations Team (FOT) reside in the EOS Operations Center (EOC), the control center for all EOS missions.

The Flight Project develops and tests the spacecraft and integrates the science instruments. The Flight Project also develops the spacecraft simulator, which will be integrated into the EOSDIS and will be operated by the FOT in the EOC.

1.5 Mission Operations Support Elements Overview

The goal of mission operations is to obtain and deliver science data to science users. To achieve this goal, the ESDIS Project manages mission operations systems and coordinates their use of support element capabilities in capturing science data and processing it into Level 0 production data sets used for higher level science processing. The FOT and Instrument Operations Teams (IOTs) use housekeeping data to monitor the health and safety of the spacecraft and instruments.

The following paragraphs summarize the roles performed by mission and support element systems.

1.5.1 Ground Systems

EOC   The EOS Operations Center will be the focal point for EOS mission operations. The EOC will consist of the Mission Operations Area (MOA), telemetry and command processing equipment, and interfaces with EDOS, Ebnet, SDVF, etc.

EDOS   The EOS Data and Operations System will provide data acquisition, Level 0 processing, archival, and data distribution.

Ebnet   The EOSDIS Backbone Network will provide interfaces between TDRSS, EDOS, EOC, GN, and the DAACs. These interfaces will be via Internet Protocol (IP) and clock and data interfaces.

FDS   The Flight Dynamics System will provide attitude determination and verification support, orbit maintenance support, planning and scheduling products, navigation system validation, and acquisition data for EPGN and SN resources. The FDS resides in the EOC and has interfaces with the EMOS, WFF, NCC, and MMFD.

TDRSS   The Tracking and Data Relay Satellite System will be used for command, telemetry, and tracking of the TERRA spacecraft.

NCC   The Network Control Center will coordinate TDRSS network support and scheduling of the TERRA spacecraft.

EPGN   The EOS Polar Ground Network (EPGN) will provide telemetry, command, tracking support and receipt of recorded science data.

1.5.2 Flight Operations Team (FOT)

The FOT conducts flight operations from the EOC. Support elements for TERRA mission operations includes the SN/TDRSS, Ebnet/NISN, FDS, and the EPGN.

Section 4.0 describes each support element in greater detail.

1.5.3 EOS Mission Operations System (EMOS)

The EMOS provides flight dynamics personnel to assist the FOT in operation of flight dynamics equipment during early orbit activities and during special attitude and orbit maneuvers. During normal mission operations the FOT operates flight dynamics systems in the EOC to provide nominal products such as ephemeredes.

EDOS operations personnel provides the EMOS with telemetry acquired via TDRSS/GN, and performs Level 0 processing of science data for subsequent transfer to the DAACs for higher level processing. During nominal operations EDOS systems are largely autonomous, and their routine functions may be performed by the FOT.

EBnet operations personnel operate network connections between the EOC and the support elements. They perform troubleshooting when anomalous data conditions occur. They coordinate troubleshooting with other ground system personnel in resolving problems.

Ground Network operations personnel provide support during spacecraft contacts as required, particularly during early orbit operations and during anomalous conditions. Ground station equipment is designed to be largely autonomous with monitor capability by the FOT.

Section 2.0 TERRA Spacecraft Mission Overview

2.1 TERRA Mission Payload Overview

The EOS TERRA mission is planned for launch in 1999. The payload consists of the Advanced Spaceborne Thermal Emission and Reflector Radiometer (ASTER), Clouds and Earth's Radiant Energy System (CERES), Multi-angle Imaging SpectroRadiometer (MISR), Moderate-Resolution Imaging Spectroradiometer (MODIS), and Measurements of Pollution in the Troposphere (MOPITT) instruments. This instrument complement has been selected to obtain information about the physical and radiative properties of clouds, air-land and air-sea exchanges of energy, carbon, and water, vertical profiles of gases, and volcanology. CERES, MISR, and MODIS are being provided by the United States, MOPPIT is provided by Canada, and ASTER is being provided by Japan. Data will be collected 24 hours a day and recorded onboard. A drawing of the TERRA Spacecraft/Payload is shown in Figure 2-1.

Real-time and recorded data will be transmitted approximately twice per orbit to the EOS Operations Center (EOC) via Tracking and Data Relay Satellite System (TDRSS). Science data will be processed to Level 0 and distributed to the EOS Distributed Active Archive Centers (DAACs) for science user retrieval. Mission operations intends to meet the mission design goal of retrieving and processing 100% of the science data.

2.2 Overall Mission Scenario

The TERRA spacecraft will be launched into a frozen, sun-synchronous orbit of **705** km altitude and 98.2 degrees inclination. The orbit provides a 16-day, 233-orbit repeat cycle. The repeat cycle will be maintained with respect to the World Reference System (WRS) to an accuracy of +/- 20 km through periodic altitude raising maneuvers. The Mean Local Time of descending node will be maintained between 10:15 and 10:45 am.

After initial activation, the spacecraft in its low Earth orbit will provide scientific observations of the Earth's atmosphere, oceans, and land surface. Data recorded on the Solid State Recorder (SSR) will be played back via TDRSS at least once per orbit. These playbacks will require approximately six minutes to accomplish via the TDRSS Ku-band Single Access (KSA) link at 150Mbps. Simultaneously, Flight Controllers in the EOC will monitor real-time telemetry (16 Kbps) and perform any required command uplinks (10 Kbps). Ranging will be performed for orbit determination.
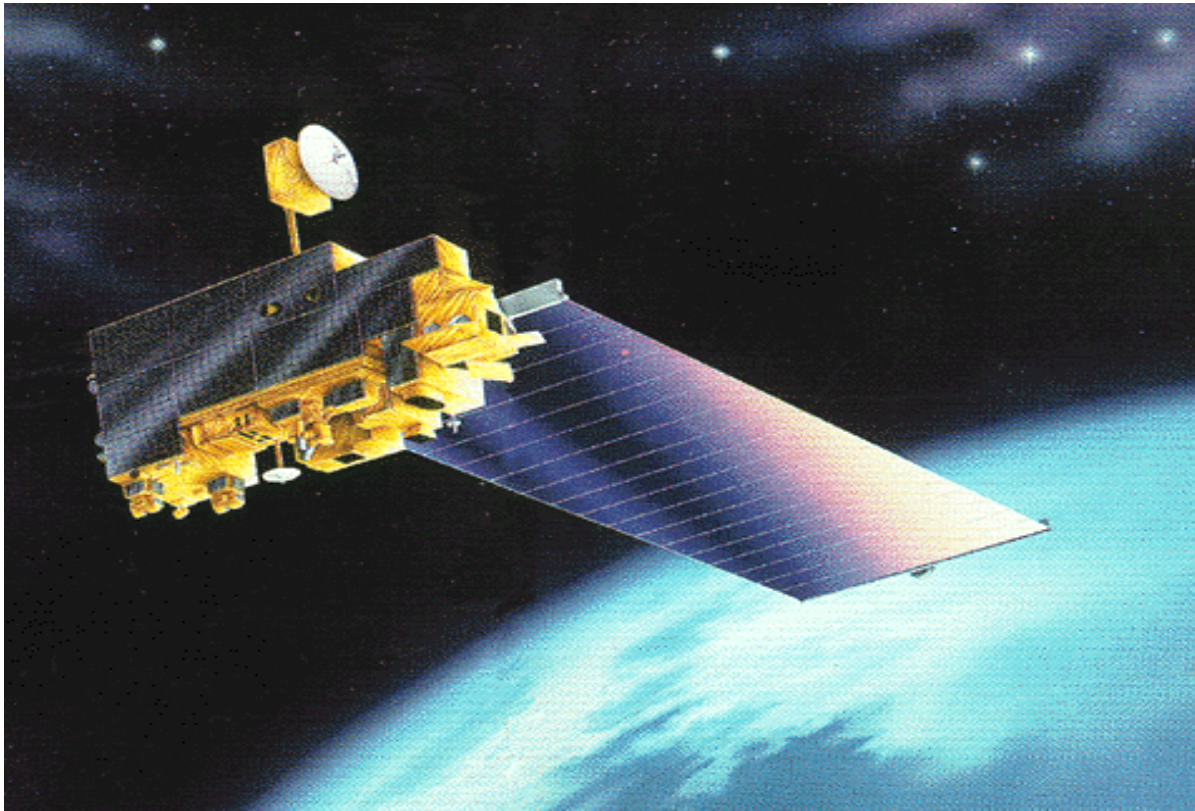
Figure 2-1. TERRA Spacecraft/ Payload Drawing

2.3 EOS TERRA Mission Description

The TERRA spacecraft is a three-axis stabilized, free-flying satellite in a sun-synchronous, repeating orbit with the following nominal orbital characteristics:

Semi-major axis	7078 km
Inclination	98.2 degrees
Eccentricity	0.0012 (frozen orbit)
Argument of perigee	90 degrees (frozen orbit)
Descending node	10:30 am+/- 15 min (local Mean solar time)

The TERRA spacecraft will provide suitable observatory platforms to support onboard environmental monitoring instruments for measuring the Earth's terrestrial and ocean surfaces, clouds, aerosols, radiation, radiative balances, and sources and sinks of greenhouse gases. The spacecraft will support communications necessary for transmission of payload instrument data to the Space Network, Ground Network, and the science user community.

The mission profile includes five phases of TERRA mission operations: pre-launch, launch and orbit acquisition, on-orbit verification, normal operations and crossover. These phases are summarized below:

Pre-launch

From initial mission operations planning and preparation of activities to launch

Launch and orbit acquisition

From Atlas II AS/Centaur liftoff to spacecraft separation

On-orbit verification

From spacecraft separation through spacecraft and instrument activation, and completion of on-orbit performance tests

Normal operation

From completion of on-orbit verification to end of spacecraft operational life

Crossover

From launch of a subsequent spacecraft in the AM series to nominal operational use of the new spacecraft

2.4 TERRA Science Objectives

The TERRA science objectives are to characterize terrestrial and ocean surfaces, clouds, radiation, aerosols, and radiance balance. The TERRA spacecraft provides a platform for five instruments to perform scientific measurements to allow fulfillment of these objectives throughout its mission.

These instruments are:

- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is a facility instrument provided by a Memorandum of Understanding with the Ministry of International Trade and Industry (MITI) of Japan. ASTER will provide high spatial resolution (15- to 90-m) multispectral images of the Earth's surface and clouds in order to better understand the physical process that effect climate change. Unlike the other instruments, ASTER does not have an instrument microprocessor. It requires the use of the Spacecraft Controls Computer (SCC) to provide it with stored commanding. ASTER is also supported by the Direct Access System. It has a Direct Downlink (DDL) to users on a scheduled basis over the X-band frequency.

- Clouds and Earth's Radiant Energy System (CERES) is a Principal Investigator instrument provided by NASA/Langley Research Center. It consists of two scanning radiometers (FWD and AFT), each with three detector channels. Configuration of its' two scanners allows one scanner to operate in the cross-track mode for complete spatial coverage from limb to limb and the other to operate with a rotating scan plane as well as in the cross-track mode (biaxial) to provide angular sampling. CERES will provide EOS with an accurate and self-consistent cloud and radiation database. Cloud and radiation flux measurements are fundamental inputs to models of oceanic and atmospheric energetics, and will also contribute to extended range weather forecasting.

- Multi-Angle Imaging SpectroRadiometer (MISR) is a Principal Investigator instrument provided by NASA/Jet Propulsion Lab (JPL). The instrument uses nine charged-coupled device based pushbroom cameras. MISR will study the climate and environmental consequences of changes in global aerosols loading, spatial and seasonal variation of different cloud types and their effect on the planetary solar radiation budget, the interaction between biophysical and atmospheric processes, and the detection of changes in the structure, distribution, and the extent of the Earth's forests, deserts, and cryosphere, and the investigation of climatic implications.
- Moderate-Resolution Imaging Spectroradiometer (MODIS) is provided by GSFC. MODIS is an EOS facility instrument designed to measure biological and physical process on a global basis every 1-2 days. MODIS will provide long-term observations from which to derive an enhanced knowledge of global dynamics and processes occurring on the surface of the Earth and in the lower atmosphere. MODIS is supported by the Direct Access System (DAS), providing a continuous X-band Direct Broadcast (DB) to geographically distributed local sites provided by the science community.
- Measurements of Pollution in the Troposphere (MOPITT) is a facility instrument provided under a Memorandum of Understanding with the Canadian Space Agency (CSA). MOPITT will measure emitted and reflected infrared radiance in the atmospheric column.

Section 3.0 TERRA Spacecraft Systems Overview

3.1 Spacecraft Systems Description

The TERRA spacecraft bus provides the platform from which the science instruments perform their observations. The bus provides the environment and systems necessary to sustain instrument operability including command capability, data collection and processing. Navigation and attitude control, communications, power, and thermal stability. Figure 3-1 provides an exploded view of the TERRA spacecraft with the various systems detailed.

3.2 Structures and Mechanisms Subsystem (SMS)

The SMS is designed to structurally support the instruments, equipment modules, and other spacecraft bus equipment. It provides the overall framework for mounting and positioning the instruments while maintaining precise pointing and alignment. The SMS vehicle frame is constructed from graphite-epoxy composite materials and uses kinematic equipment mounts to provide a high degree of stiffness and vibration dampening.

3.3 Primary Vehicle Structure

The primary vehicle structure consists of a graphite-epoxy tube truss with a rectangular cross-section. The tube elements are joined at nodes comprised of titanium fittings. The truss is divided into six bays, the aft bay providing a hexagonal truss bulkhead mounting surface for the Propulsion Subsystem (PROPS) module and propellant tanks.

3.4 Secondary Structure

The secondary vehicle structure provides the interface between various spacecraft equipment and the primary vehicle structure. The secondary structure supports the core spacecraft electrical harness, interface connector panels, close-out panels, the Solar Array Drive support, onmi antenna supports, and GN&C sensor supports.

ARRAY DEPLOYED
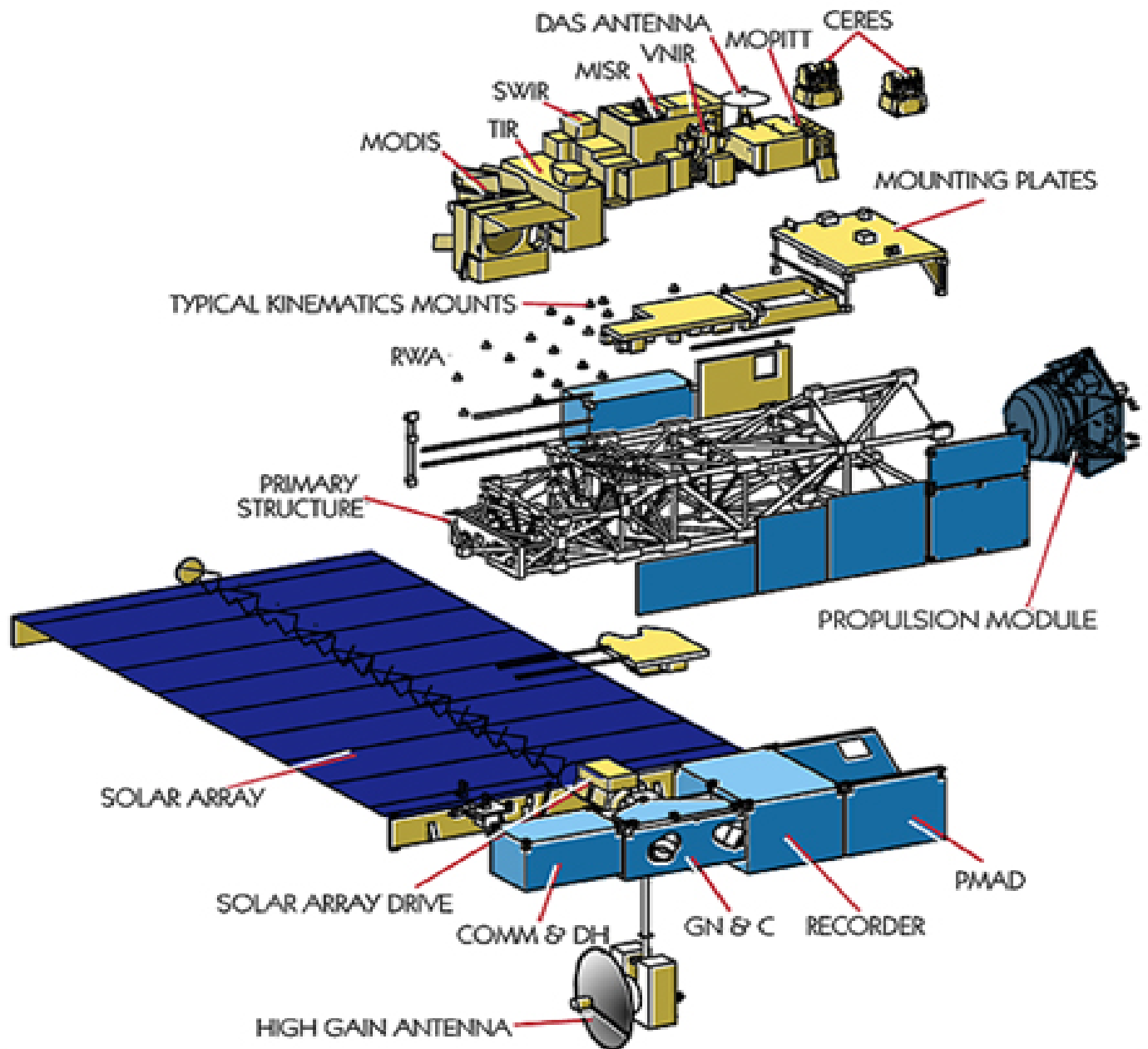
Figure 3-1.   Exploded view of the TERRA spacecraft with the various systems detailed.

3.5 Propulsion Module Structure

The Propulsion Module structure consists of an aft panel with six titanium fittings, mounted directly to the primary structure via a secondary truss of twelve graphite epoxy elements which attach to the six fittings. An adapter ring supports the propellant tank.

3.6 Equipment Module Structure

The Equipment Modules and structural panels provide mechanical support and environmental isolation for most spacecraft systems. They are designed to be sufficiently modular to allow access to given systems without the need to de-intergrate the systems from the vehicle. Access panels are generally aluminum honeycomb with aluminum facesheets, with heatpipes embedded in the panels of the EPS, SSR, and DAS for heat conveyance.

3.7 Instrument Accommodation Structure

The Instrument Accommodation Structure supports the science instruments using custom-built secondary structures or other support fittings when necessary to accommodate individual instrument mass, location, volume, and thermal requirements. ASTER Visible and Near Infrared Spectrometer (VNIR), CERES, and MOPITT mount to plates and secondary structures, and the MODIS, ASTER Thermal Infrared Spectrometer (TIR), and ASTER Short Wave Infrared Spectrometer (SWIR) mount directly to the truss.

3.8 Solar Array Drive

The Solar Array Drive, located on the upper side of the primary structure, is a precision incremental stepping device capable of rotating the SA at different speeds through a reduction gear set. The SAD has internally redundant motors and slip-ring position resolvers.

3.9 Pyrotechnic Relay Assembly

The Pyrotechnic Relay Assembly contains Arm and Fire relays which initiate Non-Explosive Actuators (NEAs) and also contains drive circuits for the DAS Waveguide Switch. The PRA is actually part of the EAS, but is included here due to its relevance to the SMS systems described in this section. The relays receive commands from the BDU to fire the NEAs, releasing the SAA and HGA mechanisms.

3.10   Kinematic Mounts

Kinematic Mounts (KMs) isolate the primary module, equipment module, and instrument structures from thermal and load distortions. 1-axis, 2axis, and 3-axis KMs are provided, to accommodate load relief in one, two, or three directions.

3.11 HGS Release Mechanism

The HGA uses five restraint devices released via ball-socket NEAs. A viscous damper provides controlled mast release motion, and redundant springs ensure deployment reliability. The mast hinge includes redundant potentiometers for monitoring motion during deployment.

3.12 Thermal Control Subsystem (TCS)

The TCS maintains all spacecraft components and instrument interfaces within their allowable thermal limits. Passive thermal control techniques include multilayer insulation (MLI), isolators, and thermal finishes. Heaters are used where necessary. Heat-pipe radiator panels in the equipment modules dissipate heat produced by spacecraft components. A capillary-pumped heat transport system (CPHTS) provides thermal control to instruments, which do not have sufficient radiator area. Tempture telemetry data is provided throughout the spacecraft to monitor the performance of this subsystem.

3.13 Instrument Thermal Control

Science instruments employ a two-tier thermal control strategy. Passive thermal coatings and radiators to reject heat from locations near the instrument field of view provide local thermal control. ASTER-TIR, ASTER-SWIR. and MOPITT requires additional active cooling performed by the CPHTS. The CPHTS consists of a fully redundant two-phase capillary pumped radiator and coldplate using anhydrous ammonia as the coolant. Instrument waste heat is absorbed by the coldplate and transferred via coolant lines to heat exchangers on the externally mounted radiator. Non-condensable gas traps and heaters provide necessary control and regulation of the system.

3.14 Spacecraft Bus Thermal Control

Thermal stability of the spacecraft primary structure is provided by passive techniques. Where required, heaters ensure adequate component temperatures. Heater control is provided by mechanical thermostats or Heater Control Electronics (HCE), depending upon the application.

The 120v general application heaters provide operational and survival thermal control using mechanical thermostats. Battery Assembly and CPHTS reservoir heaters use commendable and software driven set point thermostatically controlled heaters.

The Propulsion Module (PM) is radiatively and conductivity isolated from the rest of the spacecraft. Passive and active thermal control ensures propellant tanks, lines, valves, and thrusters are maintained at least 10 C above the freezing temperature of the propellant. 28V mechanical thermostat heaters are used in the PM.

Section 4.0 TERRA Communication System Overview

4.1 TERRA Communication System Summary

The Communication Subsystem (COMMS) provides Radio Frequency (RF) equipment for receiving commands and for transmitting spacecraft data and tracking data. This equipment receives and demodulates all command data destined for spacecraft subsystems and instruments, modulates and transmits data from the spacecraft subsystems and instruments, and receives, decodes, and transmits signals used for spacecraft tracking.

The three elements of this system are S-band transponders, Ku-band transmitters, and X-band transmitters. The S-band element interfaces with the Command and Telemetry Interface Unit (CITU) for command and telemetry. The X-band and the Ku-band transmitters interface with the Science Formatting Equipment for science data downlink. The COMMS also contains the Master Oscillator (MO) which provides spacecraft time and provides a precision frequency source to all subsystems requiring discrete timing signals.

4.2 S-band Transponders

The spacecraft has two transponders that are always operating in the receive mode. The receivers in the transponders simultaneously search for TDRSS Pseudorandom Noise (PN) code correlation and STDN Carrier Wave (CW) signal greater than the detection threshold. Upon acquisition of one signal type, the other mode will be inhibited until loss of the intial signal and subsequent return to search mode occurs.

The S-band transponders (SBTs) receive spacecraft command data and transmit spacecraft real-time Housekeeping (H/K), Health and Safety (H&S), diagnostic data, and recorded H/K telemetry. The command function includes extracting Doppler frequency information for the TDRSS Onboard Navigation System (TONS), which provides spacecraft navigation information. Two third-generation TDRSS transponders are connected via nadir omni directional antennas. The transponder receivers have two modes of operation: a TDRSS PN spread-spectrum modulation mode, and a STDN Continuous Wave (CW) modulation mode, autonomously configurable upon reception of the appropriate forward link. Once the RF signal is accepted by the transponder, it is despread if in the TDRSS Mode, and demodulated and sent to the CITUs. Both CITUs can receive from either S-band transponder, but only the active CTIU processes command data and clock, carrier lock, detector lock, code epoch, and Doppler mark indications. The standby CTIU receives the same as the active CTIU from the sending transponder, but it does not process the information. However, it can be commanded to control its own internal functions.

For normally scheduled TDRSS contacts, spacecraft navigation software computes doppler frequency predictions for onboard doppler compensation by the S-band transponder. A TDRSS uncompensated link allows for onboard doppler extraction. When required, the S-band can also perform 2-way ranging.

When in the STDN mode, the transponder will receive the uplinked PM carrier, which will be utilized to generate the coherent downlink transmitter frequency and demodulated to provide the baseband signal. The 16kHz subcarrier is demodulated and passed to the command detector in the Command and Data Handling (C&DH) subsystem from which command data will be sent to the appropriate subsystems on the spacecraft.

4.3 Ku-Band Transmitters

Ku-band transmitters are the primary method used for science data retrieval via TDRSS KSA service, using the High Gain Antenna (HGA). The spacecraft contains two KSA modulators and two KSA upconverter/transmitter elements. KSA service supports either a nominal Ku-band playback or a real-time science data downlink at 150 Mbps. The prime and redundant modulators receive real-time or playback science data controlled by the Science Formatting Equipment (SFE). The SFE is commanded to transfer the data output to the KSA modulator. The prime selected KSA modulator is always selected to be on, and either the HGA upconverter or the modulator Local Oscillator (LO) is turned on or off to enable or disable RF communication.

4.4 X-band Transmitters

X-band transmitters enable the Direct Access System (DAS) to provide a real time transmission link for selected instruments directly to user ground stations. The X-band system contains redundant DAS modulators, DAS upconverters, DAS solid state power amplifiers, and its own DAS antenna. The DAS provides high-rate downlinks direct to science data users via two types of service: Direct Broadcast (DB), and Direct Downlink (DDL). DB service supports the continuous transmission of MODIS realtime science data, and DDL service supports scheduled transmission of ASTER real time science data.

When science data cannot be obtained by normal KSA service, an alternate DAS method is available. This alternate service is called Direct Playback (DP), and provides playback recorded science data from selected SSR buffers. It can be downlinked on both the I and Q channels simultaneously at a combined rate of 150 Mbps, or on the Q channel at 105 Mbps.

4.5 Master Oscillator

The COMMS Master Oscillator (MO) produces a master time reference from a redundant MO to drive spacecraft time and provide a precision frequency source to all subsystems. A User Spacecraft Clock Calibration System (USCCS) provides time measurement comparison between UTC and the spacecraft clock. Spacecraft time is maintained to within +/- 100 usec of UTC via time corrections performed approximately every seven days.

4.6 TDRSS Onboard Navigation System

The TDRSS Onboard Navigation System (TONS) provides the Guidance, Navigation, and Control Subsystem (GN&C) with Doppler residual measurements enabling the GN&C to compute spacecraft position, velocity, aerodynamic drag, and transmitter oscillator drift. One five-minute S-band forward link service is required per orbit to maintain system accuracy.

4.7 High Gain Antenna

The High Gain Antenna (HGA) System provides the primary transmission and reception interface between the COMMS and TDRSS. A 53-inch Cassegranian reflector and gimbal system maintain TDRS pointing via the SCC and Attitude Determination and Control (ADAC) software. S-band forward and return and Ku-band return link transmissions are simultaneously supported by the HGA. Nominal operation of the HGA following launch and deployment will be initiated by stored program commands using propagated TDRS position to steer the HGA in accordance with the TDRSS contact schedule. HGA control is closed-loop: the HGA controller monitors HGA position via optical encoders and provides motor step pulses to point the HGA for TDRSS tracking or to maneuver the HGA gimbals to ground-commanded positions. Acceleration and position limits avoid unacceptable vehicle disturbances and antenna placement.

Operating modes of the HGA include:

- Slew Mode: The HGA is controlled by the FSWS to move through specified azimuth-elevation combinations at selected angular rates
- Program Track Mode: The HGA is commanded via the FSWS to initiate and maintain pointing to the selected TDRS via onboard position propagation
- Position Command Mode: The HGA is manually commanded to a ground-specified position by direction and step number command
- Hold Mode: Maintains the HGA at a fixed position until further commanded

4.8 Contingency Communications Modes

Contingency communications modes are used if nominal contact via S-band through the TERRA HGA are interrupted or prevented. During these periods, communications may be established via the TDRSS or the EPGN (Alaska (AGS), Norway (SGS), Wallops (WGS)) via the TERRA nadir or zenith omni-directional antennas. Lower TDRSS command (125bps) and telemetry (1 Kbps H&S) rates are required due to the lower gain provided via the onmi antennas. GN supports will use a 2-Kbps uplink and a 16-Kbps H/K downlink. The SSR may be dumped at 512 Kbps to the GN.

In addition the EPGN stations at AGS and SGS can recover the science data via X-band at 150 Mbps by recording the data on magnetic tape and then shipping the magnetic tape to the EDOS for processing.

Section 5.0 Mission Operations Support Elements

5.1 EOS Ground System

The EGS is an integration of EOS spacecraft ground support, science investigator support, data centers, International Partners (IP) ground stations, user networks, non-EOS ground systems, contractor facilities, NASA institutional support, and EOSDIS. Figure 5-1 provides a graphical representation of the EGS components and interfaces. EOSDIS is the dedicated and unique portion of the EGS developed by the ESDIS Project. Table 5.1 provides a summary of EGS elements and their roles.

EOSDIS, as the overall Earth science discipline data system, provides the ground system for the collection and analysis of science data to support scientists in resolving the dynamics of the Earth's components and the processes by which they interact. As part of the EOS program, the EOSDIS supports the planning, scheduling, and control of the EOS series of spacecraft, exchanging commands, data, and algorithms with Japan, Canada, the National Oceanic and Atmospheric Administration (NOAA), and any other non-NASA entities involved in the overall EOS mission.

Figure 5-1. EGS Components and Interfaces

EGS Element	Role
EOSDIS	
• EOSDIS Core System (ECS)	Provides EOS flight operations; science data processing; and EOSDIS communications and system management
• Distributed Active Archive Centers (DAACs)	Provides production, archive, and distribution of EOS and non-EOS science data products, and user support
• Version 2	Provides a working system of selected key EOSDIS services with operational elements
• Science Computing Facilities (SCFs)	Provides science data processing software/algorithms, data product quality assessment, and user support
• EOS Data and Operations System (EDOS)	Provides EOS data capture, level 0 processing, and backup archive
• EOSDIS Backbone Network (EBnet) and External Network	Provides EGS mission operations communication services and science operations communication services
• EOSDIS Test System (ETS)	Provides test data generation and EGS element simulation capabilities
• EOS Polar Ground Network	Provide space to ground and ground to space communications services for *backup* to the TERRA mission, .including X-band at (space-to-ground) at AGS and SGS. WGS will provide S-band *backup* only.
Institutional facilities	
• Flight Dynamics	Provides orbit and attitude data, and orbit adjust and maneuver computations for EOS spacecraft
• NISN	Provides communications services between the White Sands Complex (WSC) and EGS elements
• Space Network (NCC)	Provides TDRSS services for TERRA spacecraft
Participating Programs	
• EOS Spacecraft Ground Support	Provides real-time spacecraft simulations, generation and test of flight software updates, integration and test facilities, operational launch support services, and spacecraft sustaining engineering facilities and services
• International Partner Facilities	Includes interfaces with international partner facilities such as the ASTER Ground Data System (GDS), and the NASDA Earth Observation Information System (EOIS)
• Affiliated Data Centers (ADCs) & Other Data Centers (ODCs)	Provides selected Earth science data and metadata to DAACs for archive and user access; examples include the Landsat Processing System (LPS), and the TRMM Science Data and Information System (TSDIS), and the NOAA Satellite Active Archive
• User Facilities	Provides user access to EOSDIS science data
• NASA Internet (NI)	Provides external communications services between EOSDIS and EOSDIS users

Table 5-1. Summary of EGS Elements and Their Roles

5.2 EOS Mission Operations System (EMOS)

The EOS Mission Operations System (EMOS) manages and controls the TERRA spacecraft and instruments. The EMOS is responsible for Mission Planning, Scheduling, control, monitoring, and analysis in support of mission operations of the TERRA spacecraft and instruments. It provides the following services:

1. Integrate schedules for spacecraft, instrument, and ground operations,
2. Manage the pre-planned commands for spacecraft and instruments,
3. Transmit command data, either real-time commands or command loads to EDOS for uplink to the spacecraft during each real-time contact,
4. Receive and process housekeeping data from EDOS.
5. Monitor overall mission performance and performance trends, maintain on-board software and spacecraft orbit, and manage the on-board systems,
6. Monitor and manage the configuration of the EOS Operations Center (EOC),
7. Manage the real-time interfaces with the Network Control Center (NCC) and EDOS, and with other ground stations, as applicable,
8. Maintain and update the project data base and EMOS history log,
9. Provide character-based and graphical display interfaces for EMOS operators interacting with other EMOS services.
10. Provides the interface with the Flight Dynamics System (FDS).
11. Provides the interface with the ASTER Instrument Control Center (ICC).

The EMOS consists of two elements, the EOC and the Instrument Support Toolkit (IST). The EOC focuses on the command and control of the flight segment and the interaction it has with the ECS ground operations. The IST connects a principle investigator (PI) or team leader (TL) at a remote facility to the EOC in support of instrument control and monitoring.

5.3 EOS Operations Center

5.3.1 EOS Operations Center (EOC)

There is one EOC at GSFC that is responsible for coordinating the operations of all TERRA instruments, those of the United States and the International Partners, and for the operations of the spacecraft. The EOC plans and schedules the TERRA spacecraft system resources and assembles and generates conflict-free instrument schedules on the basis of preplanned management information received from the NCC, EDOS, FDS, and spacecraft analysis. The EOC merges and validates instrument software loads and command data. The EOC also provides capabilities to forward commands in real time or store them for later transmission. It validates instrument command sequences before transfer to EDOS for uplink to spacecraft. In addition, the EOC provides limit monitoring of spacecraft and instrument parameters and develops contingency plans for use during spacecraft anomalies. Figure 5-2 is a functional block diagram of the EOC.

5.3.2 EOC Architecture

The EOC design is made up of nine loosely coupled functional subsystems called services (See Figure 5-2). A key requirement of the EOC architecture is to ensure that it is designed to be scaleable and extensible to support multiple spacecraft simultaneously in varying states of development, testing, and operations. The challenge in fulfilling this requirement is that the system will evolve over a period of years before the full complement of spacecraft will be designed. Thus, the primary feature of the EOC system is an evolvable architecture that facilitates reduced life cycle costs. This is accomplished through the following characteristics:

1. A single EOC that can support multiple missions concurrently. The use of logical strings provides operational flexibility. A logical string is a collection of hardware and software resources and information about how these resources are being used to provide spacecraft and instrument control and monitoring during real-time contacts, simulations, and historical replays. A unique logical string exists for each real-time scenario (i.e., contact, simulation, and historical replay). Logical strings enable an operator to monitor data from multiple sources on the same display, allowing simultaneous support to multiple spacecraft.
2. EOC functions implemented by building blocks, allowing reuse of blocks for future missions. New software will focus on mission customization requirements.
3. Development of a database-driven system to facilitate ability to add, modifies, and adapts functions.
4. Hardware implementation that is platform independent.
5. Streamlined operational tasks and an automation framework to facilitate increased automation.

5.3.3 EOC Functional Requirements

The combination of all nine EOC services provides for normal operations as well as accommodating changes for emergencies and contingencies, including Targets of Opportunity (TOOs). TOOs are defined from an EOC point of view as late changes to schedules to accommodate science requests. The following paragraphs describe these services.
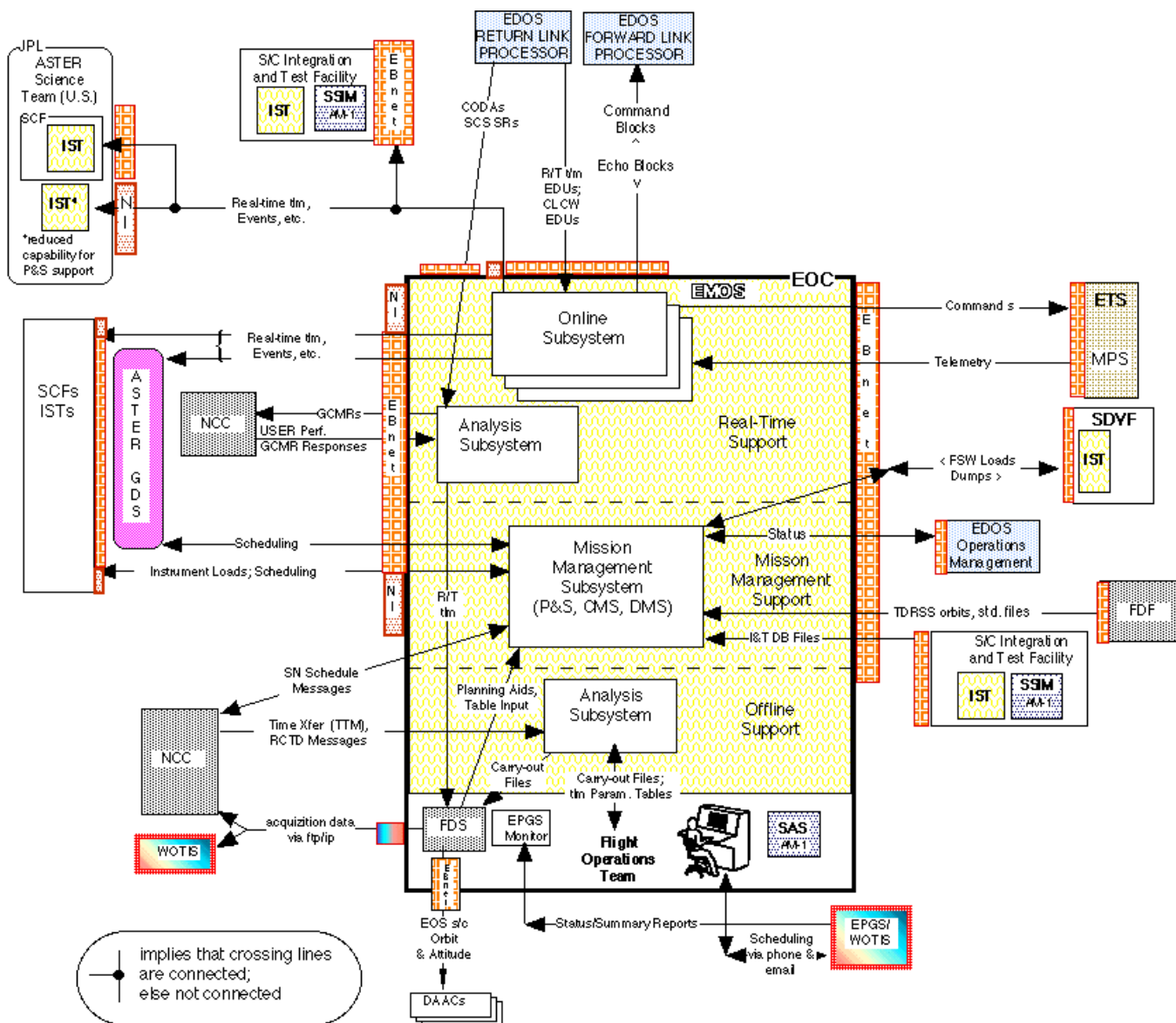
Figure 5-2. EOC Functional Diagram

5.3.4 Planning and Scheduling Service

The Planning and Scheduling Service (P&S) generates the integrated plans and schedules for spacecraft and instrument operations. These plans and schedules are dependent upon instrument science activities, instrument support activities, and spacecraft subsystem activities. As part of the Planning and Scheduling Service, the Project Scientist at the EOC may be requested to resolve instrument-scheduling conflicts while ensuring that EOS mission science objectives are met. The EOC reintroduces applicable requested activities into its planning and scheduling function when the activity does not occur because of a deviation from the schedule. Plans and schedules are provided to the SDPS as user information.

The Long Term Science Plan (LTSP) is generated by the Investigator Working Group (IWG) and contains guidelines, policy, and priorities. It is generated/updated every 6 months and covers a 5-year period. The Long Term Instrument Plan (LTIP) is also generated/updated by the IWG for the same period and provides instrument-specific information. The instrument resource profile is generated/updated weekly, covering a target week, and is produced several weeks in advance. It is based on instrument science activities, instrument support activities, the previous instrument resource profile, the long-term science and instrument plans, and resource availability and guidelines from the EOC. The EOC integrates the instrument resource profiles with its spacecraft subsystem resource profile, producing the preliminary schedule. A detailed activity schedule is generated daily, covering the next several days. The detailed activity schedule can be modified for a TOO up to 24 hours before an observation. A TOO requiring no schedule changes can be accepted up to 6 hours before the observation. A TOO that requires only real-time commands can be accepted 1 hour before the next station contact. Figure 5-3 summarizes the planning and scheduling activity.
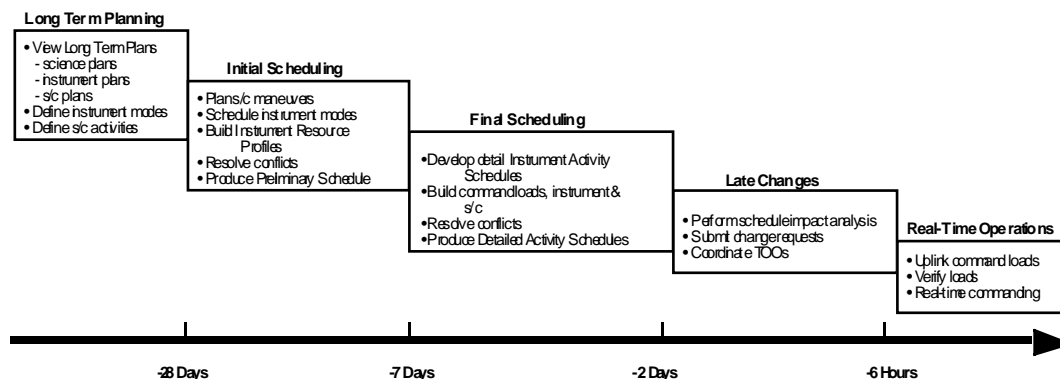
Figure 5-3. Planning and Scheduling

The EOC receives from the FDS predicted orbit data, including predicted ground track information and predicted maneuver times for scheduling. The EOC manages spacecraft resources that are not managed onboard, including scheduling the spacecraft recorders and communications subsystems.

5.3.5 Command Management Service

The Command Management Service provides management of preplanned uplink data for the EOS spacecraft and EOS instruments primarily on the basis of the detailed activity schedule. The Command Management Service accepts SCC-stored instrument commands, SCC-stored instrument tables, and instrument microprocessor memory loads and validates them for appropriateness, checking for authorized sources and for violation of selected constraints. It integrates the SCC-stored spacecraft and instrument commands in preparation for uplink, manages spacecraft computer stored command memory, packages commands for onboard storage, and produces a memory map for the spacecraft stored command processor. The service also provides high-level validation for preplanned command groups, which are stored on the ground in preparation for real-time execution.

5.3.6 Commanding Service

The Commanding Service in the EOC will provide the capability to transmit uplink data to the EOS spacecraft and instruments via EDOS. Uplink data are made available to the EOC Commanding Service by the EOC operators or the EOC Command Management Service.

The EOC operators will require that real-time spacecraft and instrument commands be constructed and uplinked in real time during contacts with the spacecraft. The EOC Commanding Service performs the processing necessary for this function. In this category, commands are either entered directly by the operator or generated from either a real-time or preplanned command group. (A command group is a logical set of commands. A preplanned command group is one that has been preprocessed by the Command Management Service and stored on the ground for later uplink, whereas a real-time command group has not undergone any preprocessing.)

5.3.7 Telemetry Processing Service

The Telemetry Processing Service provides the capability to receive and process both real-time and spacecraft recorder housekeeping data from the EOS spacecraft and instruments. This housekeeping data will be downlinked from the spacecraft and instrument in Consultative Committee for Space Data Systems (CCSDS) packets. EDOS will transfer the packets to the EOC.

When receiving real-time housekeeping telemetry, the Telemetry Processing Service decommutates the contents of the packets, performing the necessary conversions and calibration and determining values for other derived parameters. Various forms of limit checking are performed on the housekeeping parameters, including boundary limit checking on nondiscrete parameters, delta limit checking (examining the difference between successive parameter sample), and rail limit checking (checking for saturated parameter values). For each parameter being checked for boundary limits, the Telemetry Processing Service uses one of several limit sets, in which each limit set consists of definition for one or more upper and lower boundaries for the parameter. (These are commonly referred to as red/yellow, high/low limit sets.) All parameters, along with associated limits, quality, and event information, are made available to the operator of the User Interface Service. The Telemetry Processing Service also extracts a subset of the real-time telemetry stream for transfer to the FDS and the ISTs.

5.3.8 Spacecraft Analysis Service

The Spacecraft Analysis Service provides the EOC operators the capabilities needed to perform spacecraft systems management, performance analysis, trend analysis, CM, and resource management. These functions are provided on a noninterference basis with
real-time telemetry processing functions. A subset of these functions is provided in real time. The spacecraft analysis service also supports fault detection and isolation.

The EOS evaluates the performance of the spacecraft core systems and the status of instruments. Performance data are processed from spacecraft recorder housekeeping data, history files, and real-time housekeeping data. The EOC reports on the quality of the data used for the analysis, reports failures detected, and identifies marginal system operation. The EOC enables operators to analyze the performance of the power, command and data handling, thermal, communications, and guidance navigation and control subsystems.

5.3.9 Data Management Service

The EOC Data Management Service generates and maintains a Project database (PDB) and a history log. The PDB contains descriptions of all spacecraft housekeeping data formats, housekeeping parameter descriptions, command formats, display formats, and operator directives needed to evaluate the health and safety of the spacecraft and instruments. The history log is used for maintaining the records of all spacecraft and instrument operations activities. It includes commands sent to the spacecraft and instruments, telemetry data received, NCC messages sent and received, operator directives, element manager directives, a SCC ground reference image, and event and alarm messages.

5.3.10 Resource Management Service

The EOC Resource Management Service has capabilities to schedule EOC activities, manage the configuration of the EOC hardware and software, control and monitor the configuration of its components, monitor performance, manage operator and remote system access information, generate reports, and provide operations testing. It coordinates operations with EDOS and the SMC.

5.3.11 User Interface Service

The User Interface Service in the EOC provides authorized EOC personnel with access to every function, including planning and scheduling, control and monitoring, and analysis and management of the spacecraft, instruments, and the EOC itself. This User Interface Service consists of two main capabilities: a set of mechanisms through which the operator can specify actions to be taken by the system and provide responses and input and a display function through which the user can monitor the spacecraft, instruments, the EOC components, and the results of user requests.

5.3.12 Real-time Contact Manager Service

The Real-time Contact Manager is responsible for receiving periodic status information from EDOS and the Network Control Center (NCC) during real-time contacts with EOS spacecraft. This status

information includes monitor blocks and operation messages. In addition, the Real-time Contact Manager can send ground configuration messages to the NCC during a real-time contact.

5.3.13 EOC Interfaces

The primary EOC interfaces are defined as follows:

EDOS: The EOC provides spacecraft and instrument uplink data to EDOS. EDOS provides CCSDS packets containing real-time or spacecraft recorder and instrument housekeeping data, spacecraft and instrument command status data, and spacecraft processor memory dump data to the EOC. The EOC and EDOS exchange accounting, fault coordination, data operations status, and planning information. The EOC interfaces with EDOS to request changes in data delivery services and to make inquiries into data delivery status. EDOS provides the EOC with the data delivery service status.

FDS: The EOC receives from the collocated FDS workstations predicted orbit data, including predicted ground track for scheduling. The EOC also receives from the FDS contact availability times, uplink table data, and other planning products. The FDS develops plans for spacecraft maneuvers. The EOC receives, schedules, and implement these plans. The EOC provides telemetry to FDS-provided attitude support equipment collocated in the EOC for determining spacecraft attitude and to an IST located on the FDS workstations.

SDPS: The EOC sends copies of acquisition plans and schedules to the SDPS during its planning and scheduling activities to provide the user with information. The EOC provides the SDPS with spacecraft information used in DAR generation, including orbit data.

IP Instrument Control Center (ICC): The EOC exchanges planning and scheduling information with the IP ICC, sends mission status to the IP ICC, and receives instrument commands and status from the IP ICC.

Instrument Support Toolkit (IST): In its role as mission coordinator, the EOC exchanges instrument planning and scheduling information with the instrument team ISTs, complying with the concept of global access to planning and scheduling information. In response to the scheduling process, the ISTs generate instrument uplink data consisting of SCC-stored commands, SCC-stored tables, and instrument microprocessor loads that implement the scheduled observations. The EOC accepts instrument uplink data from the ISTs, validates them at a high level, and integrates them. The instrument team is responsible for the contents of its instrument microprocessor loads. In its role as overseer of mission operations, the EOC receives instrument status information from the ISTs to perform high-level monitoring.

NCC: The EOC receives from the NCC forecast and active schedules of TDRSS contacts. The EOC transmits schedule requests for TDRSS start times and duration to the NCC. The EOC and the NCC exchange messages that include status and resource reconfiguration information.

SMC: Via the SMC, the EOC receives EOS management and operation directives, including science policy and guidelines from the IWG plan contained in the LTSP and LTIP. The EOC returns EOC management and operations status.

Spacecraft Simulator (SSIM) and Software Development and Validation Facility (SDVF): The EOC receives flight software updates for uplink to the spacecraft from the SDVF. For training and simulation, the EOC sends spacecraft and instrument commands and simulator directives to the spacecraft simulator. The spacecraft simulators send telemetry data and simulator responses to the EOC. The spacecraft simulators fulfill the purpose of flight operator training, validation of operational procedures, and anomaly resolution.

The Spacecraft Analysis Software (SAS): developed by the Spacecraft Contractor for the TERRA Mission is collocated at the EOC for the use of the Flight Operations Team (FOT) in analyzing spacecraft performance in addition to the capabilities provided by the ECS Spacecraft Analysis Service. To facilitate this use, an interface is provided between the two analysis capabilities.

EOC/EPGS Interface: Located in the EOC is the EOS Polar Ground Network (EPGN) monitor capabilities to allow coordination of interoperation of the EOC with the high latitude ground stations (EPGN) via the Wallops Flight Facility (WGS). There is no interface directly to WOTIS. All schedule request will be by telephone and e-mail.

DAAC: The EOC provides the GSFC DAAC with spacecraft status information and historical data about EOS mission operation for archiving. The EOC receives from the GSFC DAAC storage status that indicates the success or failure of storage of the data the EOC sends to the DAAC.

5.3.14 Instrument Support Toolkit

An Instrument Support Toolkit (IST) is a collection of software executable programs that support remote participation by ECS instrument teams in the scheduling, monitoring and analysis of their instruments. This toolkit running at a workstation constitutes the Instrument Support Terminal. Using the IST, the Instrument Operations Team can schedule and monitor real-time telemetry, monitor replay telemetry (including spacecraft recorded telemetry), perform analysis, build command procedures, submit command requests, monitor commanding, review ground scripts, submit table loads and microprocessor memory loads, browse and submit updates to the instrument databases, receive event messages, access documentation, send and receive electronic mail to and from other ISTs and the EOC, build customized telemetry displays, and receive context-sensitive help.

The IST is a window into the EOC, providing much of the functionality available to the Flight Operations Team only distributed to the PI/TL facility. The IST can be thought of as just another user station in the EOC with the following limitations:

- No real-time command capability
- Command requests may only be made for the particular PI/TL instrument
- Planning and Scheduling update requests may only be made for the particular PI/TL instrument

5.4 Flight Operations Team (FOT)

The FOT is composed of spacecraft experts, the Flight Systems Engineering Manager (FSE), FOT Manager (FOM), and Ground Systems Engineering (GSE) Manager, all who are responsible to the Flight Operations Director (FOD). Spacecraft contractor members report to spacecraft contractor management, and ESDIS members report to the FOT Manager.

The FOT provides full-time monitoring and control of the TERRA spacecraft from launch throughout mission operations. The FOT is supported by other groups through agreements between ESDIS Project and external organizations. The FOT includes subsystem experts from the spacecraft manufacture, ESDIS subsystem engineers, and EOC flight controllers responsible for the spacecraft and instruments, integrated into a team focused on initial spacecraft and instrument activation and verification, and subsequently on daily performance of the science mission.

FOT positions will be staffed with qualified individuals who work scheduled shifts. Team shift coverage will be phased in time with major activities, precluding shift changes during major activation and spacecraft maneuvers. Shift personnel will be sufficiently knowledgeable and trained to perform functions in their specific positions during any mission phase.

The FOT Manager is the lead FOT administrative manager, and is the prime FOT interface with ECS.and NASA management. The FOT Manager provides the interface with NASA for resolution of personnel, technical and resource issues, and is responsible for preparing operations documentation including operations plans, command procedures, scripts, and analysis reports with support from other groups as required.

The Flight Systems Engineering (FSE) Manager reports to the FOT Manager, and is technically responsible to the FOD for engineering support for the spacecraft, instruments, and the project database (PDB). The FSE Manager supervises and directs off-line engineers and real-time spacecraft and instrument evaluators.

The FSE Manager is responsible for real-time monitoring of telemetry for spacecraft subsystem functionality, trends, anomalies and for analysis support when needed. Leads flight system engineers to provide on-line spacecraft expertise and additional assistance as needed in support of anomaly resolutions.

The FOT Operations Manager (FOM) is responsible for providing direction and leadership to the FOT during pre-launch, launch, on-orbit verification, and mission operations. The FOM is responsible for ensuring flight readiness of the FOT to support the mission and interfaces with the FOD, FSE Manager, and GSE Manager for status and resolution of technical and operational issues.

The Ground Systems Engineering (GSE) Manager reports to the FOT Manager and is responsible for ensuring the EMOS ground system meets the operational needs of the FOT. The GSE Manager supervises the Configuration Manager, Database Manager and software development, and maintenance personnel, manages and implements ground system CCRs, and resolves problems related to EOC ground systems.

The Flight Operations Controller/Shift Supervisor (OC/SS) is responsible for on-line operation of the EOS Operations Control Center and has responsibility for the integration of real-time operations, systems

engineering requirements, and execution of EOS operations. The OC/SS has operational authority within the EOC and is responsible for the commanding, health, and safety of the spacecraft. The OC/SS is the lead on-line interface to mission elements such as the space and ground networks, mission planning and scheduling, and data capture facilities. During contingency situations, the OC/SS will take authorized actions to contain or resolve anomalous conditions, may declare spacecraft emergencies to the SN, and is responsible for rapid notification of management and systems engineering personnel when required. The OC/SS represents FOT management during non-prime shift hours.

The Flight Operations Spacecraft Evaluator is responsible for monitoring the spacecraft bus systems during real-time operations and assists off-line engineering in trend analysis, anomaly recognition and resolution and reports to and takes direction from the OC/SS during real-time support.

The Flight Operations Instrument Evaluator is responsible for monitoring spacecraft instrument systems during real-time operations and assists off-line engineering in trend analysis, anomaly recognition, and resolution and reports to and takes direction from the OC/SS during real-time support.

The Spacecraft Activity Controller (SAC) is responsible for the operation of ground systems, EOC hardware and software, maintenance of TDRSS and Backup sites communication links and interfaces, and spacecraft commanding. The SAC will prepare for and ensure proper spacecraft operation through telemetry monitoring and uplink command verification.

The Mission Planner is responsible for spacecraft and network scheduling activities and is responsible for ensuring spacecraft uplink command loads and spacecraft contact schedules are correct and error free, and will take direction from the OC/SS in implementing real-time network scheduling changes required for non-nominal or contingency operations.

5.4.1 Mission Management Methodology

The Mission Management section of the EOC is responsible for the coordination and integration of all spacecraft Bus and Instrument subsystem activities and schedules supporting on-orbit operations. It is comprised of 3 subsystems: Planning and Scheduling (PAS), the Command Management System CMS), and the Data Management System (DMS).   PAS provides users with several tools to create and schedule pre-defined Activities, Baseline Activity Profiles (BAP's), Table Loads, and Microprocessor loads. It also provides the capability of scheduling TDRS contact supports (twice per orbit) on a weekly and daily basis and EOS Polar Ground Network (EPGN) support as required. The CMS is responsible for generating Absolute Time Command (ATC) loads and converting all uplink products (Table and Microprocessor) into spacecraft readable binary format. It also checks for any Command and Activity level constraint violations which have been defined by the user. The DMS handles and maintains file and data transfers within the EOC and between the Flight Dynamics System (FDS) and the Instrument Support Toolkit (IST's) - i.e. predicted orbital events, ground track, and spacecraft maneuver times. The interface with the Instrument sites and the EOC is accomplished via the supplied IST's. Both the FOT and IOT's will have the capability to generate, maintain, and schedule activities for execution onboard the spacecraft.

5.4.2 Data Management System

The Data Management System interfaces with several external systems - PAS, CMS, The Analysis subsystem (ANA), and the IST's. The system is primarily responsible for ingesting and validating products received from the Flight Dynamics System (FDS). The DMS receives FDS generated products (Uplink Tables & Predicted Orbital Events) , validates them, then copies them into the operational database. The CMS uses ingested table files and generates Table Loads. The PAS uses the ingested products which updates the Resource Model, a repository which maintains states, schedules and plans.

Once the products are resident on the PAS subsystem, the Event Generator process is kicked off to create instrument unique orbital events (MISR Local Mode events and CERES Sun Avoidance events).

The Analysis subsystem utilizes updated FDS data for plot generation and trend analysis. Selected validated products are then ftp'd to the IST's for use in the Planning and Scheduling phase.

5.4.3 Planning and Scheduling Methodology

As mentioned beforehand, the PAS subsystem provides the FOT and IOT's with several tools which are used to plan and coordinate spacecraft on-orbit operations. I t is the focal point for integrating spacecraft and instrument commanding functions on a daily basis. Scheduling of Activities is derived from the Long Term Science Plan (LTSP) and can be scheduled up to 7 weeks prior to the operational day at which time the Activities will be uplinked and executed onboard the spacecraft. Daily PAS functions begin with the FDS product ingest and culminate in uplink products (ATC/Table loads). Predicted orbital events are received from the FDS subsystem on a weekly (7-week) and daily (7-day) basis. Once predicted orbital events are ingested into the system, the data is both placed and updated on the Timeline (tool used to view mission plans). The Master Plan and any existing "What-if" plan is then adjusted by the Schedule Adjuster to reflect any changes in the orbital event data. This process will also reschedule those activities scheduled relative to an orbital event. Once all instrument and spacecraft activities are scheduled on the mission plan, the FOT constraint checks the mission plan for an operational day generates a conflict-free stored (ATC) command load. The ATC load is generated twice per day - one load 27 hours prior to the operational day, and the second occurring 7 hours prior to the operational day to incorporate any late changes (mainly ASTER driven) to the mission plan. Figure 5-4 depicts the Planning and Scheduling "Day in the Life" scenario and Figure 5-5 depicts the daily Load Generation Concept.
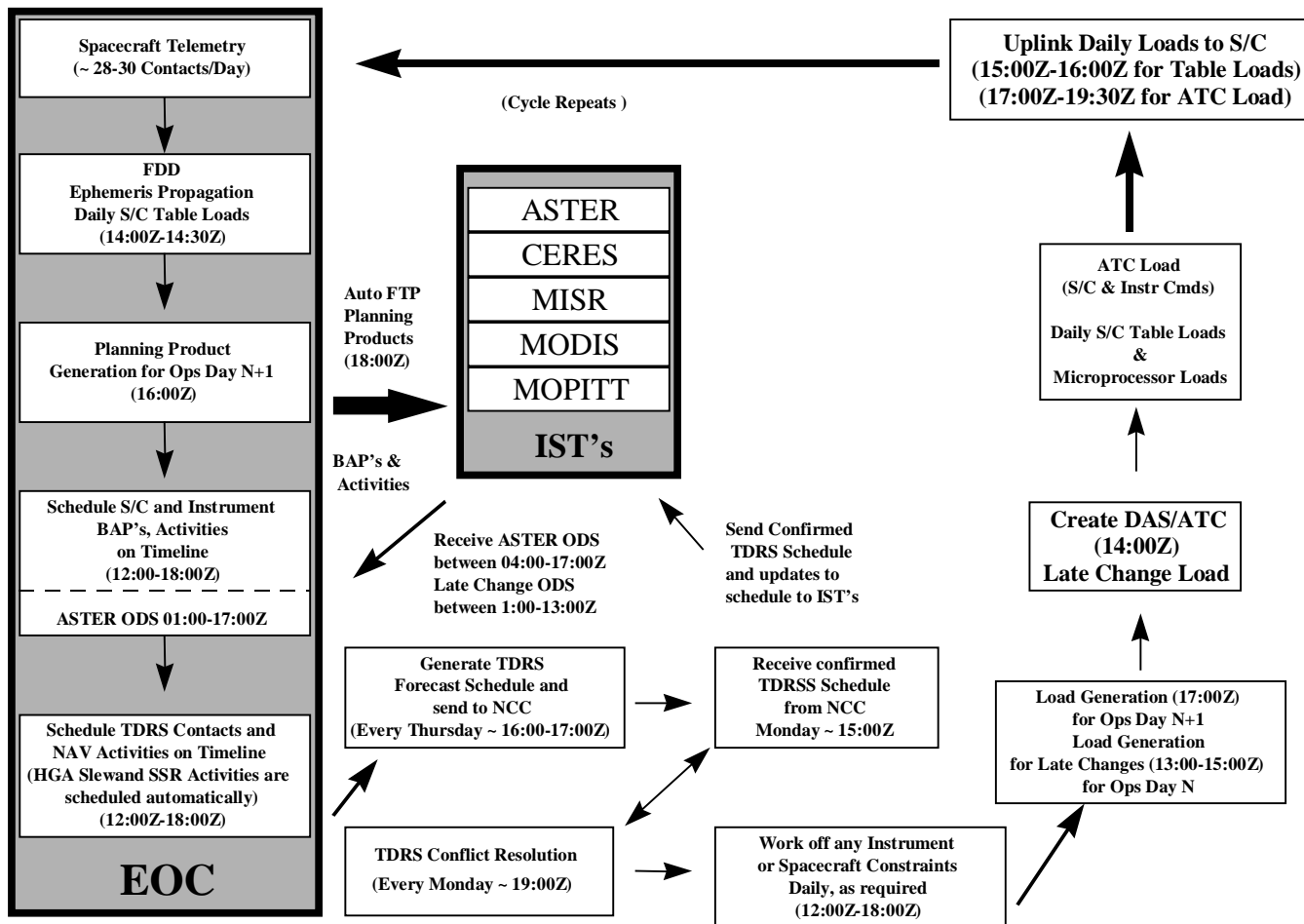
Figure 5-4. Day in the Life Planning and Scheduling Scenario

5.4.4 Command Management Methodology

The CMS provides the generation and management of pre-planned spacecraft loads for the EOS spacecraft and instruments based on the Detailed Activity Schedule (DAS). It accepts Spacecraft Controls Computer (SCC) stored commands, SCC instrument tables and Microprocessor memory

loads. Once all input is received into the CMS system, validation and constraint checking is performed (command and activity level) to ensure no user-defined constraints are violated. The CMS also provides two types of memory modeling for the AM1 spacecraft - the Spacecraft model, and the Image model. The Spacecraft model maintains the current and predicted contents of the ATC buffer, the RTCS buffer, and spacecraft tables. The ATC buffer maintains a complete listing of the 3000 stored command locations on the spacecraft. Each command in the ATC buffer contains mnemonic and submnemonic values, as well as execution time and memory location. The RTCS buffer model a complete listing of all 128 RTCS buffers.

The Table buffer model contains all information relevant to the spacecraft's tables. The Image model maintains a binary map of all spacecraft memory with the exception of the instrument microprocessors. This includes ATC, RTCS, Flight Software and Tables. Each time a modification is made to spacecraft memory, the Image model is updated during the Load Generation process.
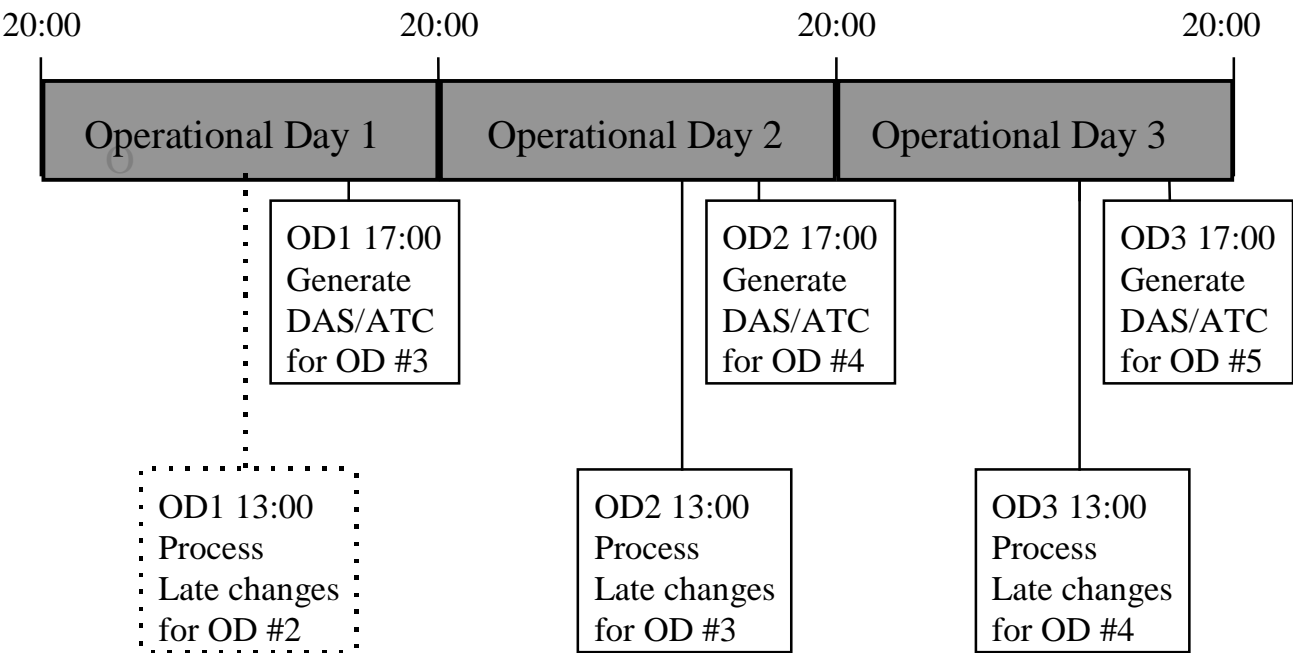
- Operational Day begins at 20:00 GMT
- One Day schedule processed 27 hours prior to start of Operational Day
- Late Changes processed 7 hours prior to start of Operational Day

Figure 5-3. PAS "Day-in-the-Life" Load Generation Concept

5.4.5 EOC/NCC Interface

The TERRA EOC utilizes the Network Control Center for scheduling real-time support with the TDRSS spacecraft. The EOC submits schedule requests and link configuration requests to the NCC via the Communications Contact Scheduler tool provided by the PAS subsystem. The NCC provides management of

resources for scheduling, controlling, and monitoring the performance of the Space Flight Tracking and Data Network (STDN). This function includes coordinating the control of available network resources, schedule processing, conflict resolution, emergency scheduling, network testing, performance monitoring/fault isolation, acquisition data dissemination, and database maintenance. In addition, the NCC is responsible for launch and real-time support of the TERRA spacecraft throughout the lifetime of the mission. The interface for scheduling between the NCC and the TERRA EOC is provided by NASCOM via TCP/IP network protocol and is documented in the *Interface Control Document Between the Network Control Center Data System and the Mission Operations Centers (530-ICD-NCCDS/MOC).* The operations interface procedures are documented in section 4 of the *Operations Interface Procedures Between the Network Control Center and the Spacecraft Tracking and Data Network Users, 534-OIP-NCC/STDN* Users.

5.4.6 NCC Database and Service Specification Codes

The TERRA EOC is responsible for providing the NCC with required database parameter values and Service Specification Codes prior to scheduling support via TDRS. Codes have been developed and are resident in the NCC database for SSA, MA and KSA contact support. The main database parameters include standard setup values required to configure the White Sands Complex (WSC) for real-time support. Some of these parameters include Spacecraft Identification Code (unique for each S/C), User Interface Channels, Support Identifiers, allowable TDRS's allocated for support, Port addresses and Data Stream Id's. Service Specification Codes are a subset of the NCC database which the EOC uses on a routine basis to interface with the NCC. A Service Specification Code is a set of fixed and reconfigurable parameters which define a single service for a given SN user. Each code contains a specific service configuration for forward, return and tracking services which is derived from the values initially provided during the development of the database. Values such as forward and return data rates, coherency, polarization, transmit frequency, data coding and Doppler compensation are included in each Service Specification Code

SERVICE SPECIFICATION CODES

Ku-band Single Access Forward Normal (KuSAF-N) Service

```
SIC ................................................... 1873
Service Specification Code ID (N##) .................... N91
Service Specification Code Type ....................... KuSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ...................
Maximum Data Rate  (000001000 to 025000000 bps) ....... 000000000
*Initial Data Rate (000001000 to 025000000 bps) ....... 000000000
*Receiver Frequency (1375000000 to 1380000000 daHz) ... 1377500000
*Command Channel PN Modulation ........................ No
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. Yes
*TSW Set ID (AAAAAAAAAA) ..............................
&Power Mode (NormalPower or HighPower) ................ NormalPower
```

Ku-band Single Access Return Normal (KuSAR-N) Service

```
SIC ................................................... 1873
Service Specification Code ID (O## to R##) ............ P01
Service Specification Code Type ....................... KuSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration (Dual or SingleIdentical) ... Dual
DG1 Channel Configuration (I,Q,IQ) .................... I
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Autotrack (0=Enabled or 1=Disabled) .................. 1
*Data Group (1 or 2) .................................. 2
*DG1 Mode (1=coho/PN=IQ,2=noncoho,3=coho/PN=Ionly) .... 2
*DG2 Type (1=noncoho or 2=coho) ....................... 1
*Minimum EIRP (0.1 dBW) ............................... +522
*Maximum EIRP (0.1 dBW) ............................... +540
*Transmit Frequency (1489000000 to 1512000000 daHz) ... 1500340000
*I/Q Power Ratio (0.1 dB) ............................. 000
*TSW Set ID (AAAAAAAAAA) ..............................

I channel:
  User Interface Channel ID (UIFC ID) ................. W91,W81
  Symbol Format Conversion ............................ No
  Data Coding (U=Uncoded or C=Coded) .................. C
  Maximum MDM Data Rate  (000001000 to 002000000 bps) .. 0
  Maximum HDRM Data Rate (000125000 to 048000000 bps) .. 0
  Maximum Data Rate      (000001000 to 150000000 bps) .. 075000000
  *Initial Data Rate     (000001000 to 150000000 bps) .. 075000000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1

Q channel:
  User Interface Channel ID (UIFC ID) ................. W92,W82
  Symbol Format Conversion ............................ No
  Data Coding (U=Uncoded or C=Coded) .................. C
  Maximum MDM Data Rate  (000001000 to 002000000 bps) .. 0
  Maximum HDRM Data Rate (000125000 to 048000000 bps) .. 0
  Maximum Data Rate      (000001000 to 150000000 bps) .. 075000000
  *Initial Data Rate     (000001000 to 150000000 bps) .. 075000000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1
Specification Codes for EOS AM-1
```

Multiple Access Forward (MAF) Service Specification Code

```
Service Specification Code ID (A##) .................... A01
Service Specification Code Type ....................... MAF
Service Configuration (Normal) ........................ Normal
User Interface Channel ID (UIFC ID) ................... W21, W11
Maximum Data Rate  (000000100 to 000300000 bps) ....... 000001000
*Initial Data Rate (000000100 to 000300000 bps) ....... 000001000
*Receiver Frequency (0210630000 to 0210650000 daHz) .... 0210640625
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAAA) ..............................


SIC .................................................. 1873
Service Specification Code ID (A##) .................... A02
Service Specification Code Type ....................... MAF
Service Configuration (Normal) ........................ Normal
User Interface Channel ID (UIFC ID) ................... W21, W11
Maximum Data Rate  (000000100 to 000300000 bps) ....... 000001000
*Initial Data Rate (000000100 to 000300000 bps) ....... 000001000
*Receiver Frequency (0210630000 to 0210650000 daHz) .... 0210640625
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAAA) ..............................


SIC .................................................. 1873
Service Specification Code ID (A##) .................... A03
Service Specification Code Type ....................... MAF
Service Configuration (Normal) ........................ Normal
User Interface Channel ID (UIFC ID) ................... W23, W13
Maximum Data Rate  (000000100 to 000300000 bps) ....... 000001000
*Initial Data Rate (000000100 to 000300000 bps) ....... 000001000
*Receiver Frequency (0210630000 to 0210650000 daHz) .... 0210640625
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAAA) ..............................


SIC .................................................. 1873
Service Specification Code ID (A##) .................... A04
Service Specification Code Type ....................... MAF
Service Configuration (Normal) ........................ Normal
User Interface Channel ID (UIFC ID) ................... W23, W13
Maximum Data Rate  (000000100 to 000300000 bps) ....... 000001000
*Initial Data Rate (000000100 to 000300000 bps) ....... 000001000
*Receiver Frequency (0210630000 to 0210650000 daHz) .... 0210640625
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAAA) ..............................
```

```
SIC ...................................................... 1873
Service Specification Code ID (O## to R##) ............. P03
Service Specification Code Type ........................ KuSAR
Service Configuration (Normal or Shuttle) .............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration (Dual or SingleIdentical) .... SingleIdentical
DG1 Channel Configuration (I,Q,IQ) ..................... I
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Return Channel Time Delay .............................. No
*Polarization (Left or Right) .......................... Right
*Autotrack (0=Enabled or 1=Disabled) ................... 1
*Data Group (1 or 2) ................................... 2
*DG1 Mode (1=coho/PN=IQ,2=noncoho,3=coho/PN=Ionly) ..... 2
*DG2 Type (1=noncoho or 2=coho) ........................ 1
*Minimum EIRP (0.1 dBW) ................................ +522
*Maximum EIRP (0.1 dBW) ................................ +540
*Transmit Frequency (1489000000 to 1512000000 daHz) .... 1500340000
*I/Q Power Ratio (0.1 dB) .............................. 000
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W91,W81
  Symbol Format Conversion ............................. No
  Data Coding (U=Uncoded or C=Coded) ................... C
  Maximum MDM Data Rate  (000001000 to 002000000 bps) .. 0
  Maximum HDRM Data Rate (000125000 to 048000000 bps) .. 0
  Maximum Data Rate      (000001000 to 150000000 bps) .. 075000000
  *Initial Data Rate     (000001000 to 150000000 bps) .. 075000000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1

Q channel:
  User Interface Channel ID (UIFC ID) ..................
  Symbol Format Conversion ............................. No
  Data Coding (U=Uncoded or C=Coded) ................... C
  Maximum MDM Data Rate  (000001000 to 002000000 bps) .. 0
  Maximum HDRM Data Rate (000125000 to 048000000 bps) .. 0
  Maximum Data Rate      (000001000 to 150000000 bps) .. 075000000
  *Initial Data Rate     (000001000 to 150000000 bps) .. 075000000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1
```

Multiple Access Return (MAR) Service Specification Code

```
SIC ...................................................... 1873
Service Specification Code ID (B## or C##) ............. B01
Service Specification Code Type ........................ MAR
Service Configuration (Normal) ......................... Normal
Data Source Configuration (Dual or SingleIdentical) .... Dual
Channel Configuration (I,Q,IQ) ......................... IQ
Receiver Configuration (Cross or Normal) ............... Normal
Return Channel Time Delay .............................. No
```

```
*Mode (1=coherent,2=non-coherent) ...................... 1
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +330
*Transmit Frequency (0228740000 to 0228760000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W71, W61
  Symbol Format Conversion ............................ No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) .................... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W72, W62
  Symbol Format Conversion ............................ No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) .................... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1
```

```
SIC ...................................................... 1873
Service Specification Code ID (B## or C##) ............. B02
Service Specification Code Type ....................... MAR
Service Configuration (Normal) ........................ Normal
Data Source Configuration (Dual or SingleIdentical) .... Dual
Channel Configuration (I,Q,IQ) ........................ IQ
Receiver Configuration (Cross or Normal) .............. Normal
Return Channel Time Delay ............................. No
*Mode (1=coherent,2=non-coherent) ..................... 2
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +330
*Transmit Frequency (0228740000 to 0228760000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W71, W61
  Symbol Format Conversion ............................ No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) .................... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W72, W62
  Symbol Format Conversion ............................ No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) .................... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion (0=Normal,1=Inverted) ................. 1
```

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```
SIC ................................................... 1873
Service Specification Code ID (B## or C##) ............. B03
Service Specification Code Type ........................ MAR
Service Configuration (Normal) ......................... Normal
Data Source Configuration (Dual or SingleIdentical) .... Dual
Channel Configuration (I,Q,IQ) ......................... IQ
Receiver Configuration (Cross or Normal) ............... Normal
Return Channel Time Delay .............................. No
*Mode (1=coherent,2=non-coherent) ...................... 1
*Minimum EIRP (0.1 dBW) ................................ +249
*Maximum EIRP (0.1 dBW) ................................ +330
*Transmit Frequency (0228740000 to 0228760000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) .............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............. 0
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W75, W65
  Symbol Format Conversion ............................. No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) ..................... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W76, W66
  Symbol Format Conversion ............................. No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) ..................... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1
```

```
SIC ............................................... 1873
Service Specification Code ID (B## or C##) ............. B04
Service Specification Code Type ...................... MAR
Service Configuration (Normal) ........................ Normal
Data Source Configuration (Dual or SingleIdentical) .... Dual
Channel Configuration (I,Q,IQ) ........................ IQ
Receiver Configuration (Cross or Normal) .............. Normal
Return Channel Time Delay ............................. No
*Mode (1=coherent,2=non-coherent) ..................... 2
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +330
*Transmit Frequency (0228740000 to 0228760000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W75, W65
  Symbol Format Conversion ............................. No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) ..................... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W76, W66
  Symbol Format Conversion ............................. No
  Maximum MDM Data Rate  (000000000 to 000150000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 000150000 bps) .. N/A
  Maximum Data Rate      (000001000 to 000150000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 000150000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S) ..................... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion (0=Normal,1=Inverted) .................. 1
```

S-band Single Access Forward Normal (SSAF-N) Service

```
SIC ............................................... 1873
Service Specification Code ID (H##) ................... H01
Service Specification Code Type ...................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000010000
*Receiver Frequency (0204100000 to 0212000000 daHz) .... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Left
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
```

```
&Power Mode (NormalPower or HighPower) ................. NormalPower


SIC ................................................... 1873
Service Specification Code ID (H##) ................... H02
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000010000
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower

SIC ................................................... 1873
Service Specification Code ID (H##) ................... H03
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W24,W14
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000000125
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower
```

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```
SIC ...................................................... 1873
Service Specification Code ID (H##) .................... H04
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W24,W14
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000010000
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Left
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower


SIC ...................................................... 1873
Service Specification Code ID (H##) .................... H09
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000010000
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Left
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower


SIC ...................................................... 1873
Service Specification Code ID (H##) .................... H10
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000010000
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower
```

```
SIC ............................................... 1873
Service Specification Code ID (H##) ................... H11
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000000125
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. No
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower


SIC ............................................... 1873
Service Specification Code ID (H##) ................... H12
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000000125
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ NormalPower

SIC ............................................... 1873
Service Specification Code ID (H##) ................... H13
Service Specification Code Type ....................... SSAF
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
User Interface Channel ID (UIFC ID) ................... W22,W12
Maximum Data Rate  (000000100 to 007000000 bps) ....... 000010000
*Initial Data Rate (000000100 to 007000000 bps) ....... 000000125
*Receiver Frequency (0204100000 to 0212000000 daHz) ... 0210640625
*Command Channel PN Modulation ........................ Yes
*Polarization (Left or Right) ......................... Right
*Doppler Compensation ................................. Yes
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................
&Power Mode (NormalPower or HighPower) ................ HighPower
```

S-band Single Access Return Normal (SSAR-N) Service

```
SIC ............................................... 1873
Service Specification Code ID (I## to L##) ............ J01
Service Specification Code Type ....................... SSAR
```

```
Service Configuration (Normal or Shuttle) .............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration .............................. Dual
DG1 Channel Configuration (I,Q,IQ) ..................... IQ
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Receiver Configuration (Cross or Normal) ............... Normal
SSA Combining .......................................... No
Return Channel Time Delay .............................. No
*Polarization (Left or Right) .......................... Left
*Data Group (1 or 2) ................................... 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type .............................................. N/A
*Minimum EIRP (0.1 dBW) ................................ +249
*Maximum EIRP (0.1 dBW) ................................ +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) .............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............. 0
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ................................................. 1873
Service Specification Code ID (I## to L##) ............. J02
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Left
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 2
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1
```

```
SIC ........................................................ 1873
Service Specification Code ID (I## to L##) ............. J03
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ...................................................... 1873
Service Specification Code ID (I## to L##) ............. J04
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 2
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ........................................................ 1873
Service Specification Code ID (I## to L##) ............. J05
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) .............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration .............................. Dual
DG1 Channel Configuration (I,Q,IQ) ..................... IQ
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Receiver Configuration (Cross or Normal) ............... Normal
SSA Combining .......................................... No
Return Channel Time Delay .............................. No
*Polarization (Left or Right) .......................... Left
*Data Group (1 or 2) ................................... 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 4
*DG2 Type .............................................. N/A
*Minimum EIRP (0.1 dBW) ................................ +249
*Maximum EIRP (0.1 dBW) ................................ +370
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) .............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............. 0
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000256000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC .......................................................... 1873
Service Specification Code ID (I## to L##) ............. J06
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 4
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +370
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000256000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1
```

```
SIC ...................................................... 1873
Service Specification Code ID (I## to L##) ............. J07
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) .............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration .............................. Dual
DG1 Channel Configuration (I,Q,IQ) ..................... IQ
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Receiver Configuration (Cross or Normal) ............... Normal
SSA Combining .......................................... No
Return Channel Time Delay .............................. No
*Polarization (Left or Right) .......................... Right
*Data Group (1 or 2) ................................... 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type .............................................. N/A
*Minimum EIRP (0.1 dBW) ................................ +001
*Maximum EIRP (0.1 dBW) ................................ +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) .............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............. 0
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W75, W65
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W76, W66
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ......................................................... 1873
Service Specification Code ID (I## to L##) ............. J08
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Left
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +249
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W75, W65
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W76, W66
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000016000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.10%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ................................................... 1873
Service Specification Code ID (I## to L##) ............. J11
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) .............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration .............................. Dual
DG1 Channel Configuration (I,Q,IQ) ..................... IQ
DG2 Modulation (BPSK or QPSK) .......................... QPSK
Receiver Configuration (Cross or Normal) ............... Normal
SSA Combining .......................................... No
Return Channel Time Delay .............................. No
*Polarization (Left or Right) .......................... Right
*Data Group (1 or 2) ................................... 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type .............................................. N/A
*Minimum EIRP (0.1 dBW) ................................ +001
*Maximum EIRP (0.1 dBW) ................................ +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) .............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............. 0
*TSW Set ID (AAAAAAAAA) ................................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1
```

```
SIC ....................................................... 1873
Service Specification Code ID (I## to L##) ............. J12
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 2
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +001
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. -60
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................. No
  Data Coding (uncoded,code1,code2,code3) .............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) .................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................. 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ......... 1




SIC ....................................................... 1873
Service Specification Code ID (I## to L##) ............. J13
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
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```
Antenna (SA1,SA2,Either) .............................. Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 1
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +001
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. 0
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) ................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1

Q channel:
  User Interface Channel ID (UIFC ID) ................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1
```

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SIC .......................................................... 1873
Service Specification Code ID (I## to L##) ............. J14
Service Specification Code Type ........................ SSAR
Service Configuration (Normal or Shuttle) ............. Normal
Antenna (SA1,SA2,Either) ............................... Either
Data Source Configuration ............................. Dual
DG1 Channel Configuration (I,Q,IQ) .................... IQ
DG2 Modulation (BPSK or QPSK) ......................... QPSK
Receiver Configuration (Cross or Normal) .............. Normal
SSA Combining ......................................... No
Return Channel Time Delay ............................. No
*Polarization (Left or Right) ......................... Right
*Data Group (1 or 2) .................................. 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 2
*DG2 Type ............................................. N/A
*Minimum EIRP (0.1 dBW) ............................... +001
*Maximum EIRP (0.1 dBW) ............................... +450
*Transmit Frequency (0221600000 to 0230000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ............................. 0
*Despun Antenna (0=NoType,1=Type1,2=Type2) ............ 0
*TSW Set ID (AAAAAAAAA) ...............................

I channel:
  User Interface Channel ID (UIFC ID) .................. W73, W63
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000016000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1

Q channel:
  User Interface Channel ID (UIFC ID) .................. W74, W64
  Symbol Format Conversion ............................ No
  Data Coding (uncoded,code1,code2,code3) ............. code1
  Maximum MDM Data Rate  (000000000 to 002000000 bps) .. N/A
  Maximum HDRM Data Rate (000125000 to 003000000 bps) .. N/A
  Maximum Data Rate      (000001000 to 003000000 bps) .. 000256000
  *Initial Data Rate     (000000100 to 003000000 bps) .. 000001000
  *Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-M
  *Data Stream ID (three-digit octal) ................. 355
  *Data Bit Jitter (0.00%,0.01%,0.10%) ................ 0.01%
  *G2 Inversion if code1 (0=Normal,1=Inverted) ........ 1
```

Tracking Normal (Track-N) Service Specification Code

```
SIC ................................................... 1873
Service Specification Code ID (T##) ................... T01
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 2
Return Service Type ................................... MA
@Forward-Link Reference SSC ID ........................ A01
@Return-Link Reference SSC ID ......................... B01
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/1
@Time Transfer Required ............................... Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255

Service Specification Code ID (T##) ................... T02
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 1
Return Service Type ................................... MA
@Forward-Link Reference SSC ID ........................
@Return-Link Reference SSC ID ......................... B02
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/10
@Time Transfer Required ............................... No
@Number of Time Transfer Samples (0, 20-255) .......... 0


Service Specification Code ID (T##) ................... T03
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 2
Return Service Type ................................... MA
@Forward-Link Reference SSC ID ........................ A02
@Return-Link Reference SSC ID ......................... B01
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/1
@Time Transfer Required ............................... Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255
```

```
Service Specification Code ID (T##) .................... T04
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H01
@Return-Link Reference SSC ID .......................... J05
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T05
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H02
@Return-Link Reference SSC ID .......................... J06
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T09
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H09
@Return-Link Reference SSC ID .......................... J01
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T10
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... J02
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) ........... 0
```

```
SIC .................................................. 1873
Service Specification Code ID (T##) ................... T11
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 2
Return Service Type ................................... SSA
@Forward-Link Reference SSC ID ........................ H11
@Return-Link Reference SSC ID ......................... J11
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/1
@Time Transfer Required ............................... Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255


SIC .................................................. 1873
Service Specification Code ID (T##) ................... T12
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 1
Return Service Type ................................... SSA
@Forward-Link Reference SSC ID ........................
@Return-Link Reference SSC ID ......................... J12
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/10
@Time Transfer Required ............................... No
@Number of Time Transfer Samples (0, 20-255) .......... 0


SIC .................................................. 1873
Service Specification Code ID (T##) ................... T13
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 2
Return Service Type ................................... SSA
@Forward-Link Reference SSC ID ........................ H12
@Return-Link Reference SSC ID ......................... J11
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/1
@Time Transfer Required ............................... Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255


Service Specification Code ID (T##) ................... T14
Service Specification Code Type ....................... Tracking
Tracking Configuration (Normal or Cross) .............. Normal
Range Tracking ........................................ Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ........ 2
Return Service Type ................................... SSA
@Forward-Link Reference SSC ID ........................ H01
@Return-Link Reference SSC ID ......................... J01
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............ 1/1
@Time Transfer Required ............................... Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255


SIC .................................................. 1873
Service Specification Code ID (T##) ................... T15
```

```
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H10
@Return-Link Reference SSC ID .......................... J03
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255


SIC ................................................... 1873
Service Specification Code ID (T##) .................... T16
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... J04
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) .......... 0


Service Specification Code ID (T##) .................... T17
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H09
@Return-Link Reference SSC ID .......................... J05
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255


Service Specification Code ID (T##) .................... T18
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H10
@Return-Link Reference SSC ID .......................... J06
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) .......... 255
```

```
SIC ...................................................... 1873
Service Specification Code ID (T##) .................... T19
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H02
@Return-Link Reference SSC ID .......................... J03
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC ...................................................... 1873
Service Specification Code ID (T##) .................... T20
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H03
@Return-Link Reference SSC ID .......................... J07
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC ...................................................... 1873
Service Specification Code ID (T##) .................... T21
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H04
@Return-Link Reference SSC ID .......................... J08
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255

SIC ...................................................... 1873
Service Specification Code ID (T##) .................... T22
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H13
@Return-Link Reference SSC ID .......................... J12
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC ...................................................... 1873
Service Specification Code ID (T##) .................... T23
```

```
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... J11
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) ........... 0


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T24
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H11
@Return-Link Reference SSC ID .......................... J13
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T25
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... J14
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) ........... 0


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T26
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H12
@Return-Link Reference SSC ID .......................... J13
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T27
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
```

```
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H13
@Return-Link Reference SSC ID .......................... J11
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T28
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... Yes
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 2
Return Service Type .................................... SSA
@Forward-Link Reference SSC ID ......................... H13
@Return-Link Reference SSC ID .......................... J13
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/1
@Time Transfer Required ................................ Yes
@Number of Time Transfer Samples (0, 20-255) ........... 255


Service Specification Code ID (T##) .................... T41
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... No
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... KSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... P01
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) ........... 0


SIC .................................................... 1873
Service Specification Code ID (T##) .................... T43
Service Specification Code Type ........................ Tracking
Tracking Configuration (Normal or Cross) ............... Normal
Range Tracking ......................................... No
Doppler Tracking (0=NotRequired,1=1way,2=2way) ......... 1
Return Service Type .................................... KSA
@Forward-Link Reference SSC ID .........................
@Return-Link Reference SSC ID .......................... P03
@Sample Rate (1/1,1/5,1/10,1/60,1/300 sec) ............. 1/10
@Time Transfer Required ................................ No
@Number of Time Transfer Samples (0, 20-255) ........... 0
```

5.4.7 Database Change Procedures

When the TERRA Project determines a need to either change or add a new Configuration Code, the EOC will submit a Database Change Request (DBCR) to the NCC Database Manager (DBM). This is accomplished via an email message with the following information:

To:	SN DBM
From:	FOT Mission Planner
Subject:	Database update/change, etc.

Body - Instructions for desired update/change

The DBM will then review the request, verify that the request meets approved SN support commitments and implement the desired changes. Once all changes have been made, the DBM will send a Database Change Notification to the originator along with an official hard copy (usually Configuration Codes) of the changes.

5.4.8 Points of Contact for FOT Support

Phone numbers and titles of key FOT positions **TBS**

5.5 EOS Data Operations System (EDOS)

5.5.1 General

EDOS is the EOS data handling and delivery system which provides Level 0 data processing services for the TERRA mission. EDOS provides capabilities for return link data capture, data handling, data distribution, backup archival data storage, and forward link data handling.

EDOS is distributed over several facilities as follows: one Ground Station Interface Facility (GSIF) (note: The TERRA mission will be supported via the GSIF located at the TDRSS Ground Terminal (TGT) at White Sands, New Mexico) located at the White Sands Complex (WSC) near Las Cruces, New Mexico, the Level Zero Processing Facility (LZPF) and the Sustaining Engineering Facility (SEF) at GSFC, Greenbelt, Maryland; and the Data Archive Facility (DAF) at a separate location from the primary EOS data archives. Figure 5-4 depicts the EDOS configuration. The EOS Polar Ground Stations (EPGS) are planned to be used in a contingency mode only for high rate science data capture and for the forward link commands and the low-rate return link telemetry. The high rate data will be recorded on magentic tape and shipped to EDOS for processing.

The GSIF provides short-term data capture for high rate data, return link quality assessment, forwarding of high rate return link data to the LZPF and operations management and system support functionality for GSIF operations.

The LZPF provides forward link processing, high and low rate return link service processing, management of LZPF operations as well as centralized EDOS operations management, production data handling and delivery, and system support functionality. Specific operational requirements for EDOS services will be contained in Operations Agreement (OA) documents between each EOSDIS Ground System (EGS) element and EDOS.

The Data Archive Facility (DAF) provides a backup archive of Level 0 data to the Distributed Active Archive Centers (DAACs).

The Sustaining Engineering Facility (SEF) provides EDOS engineering support services and SEF system support services.
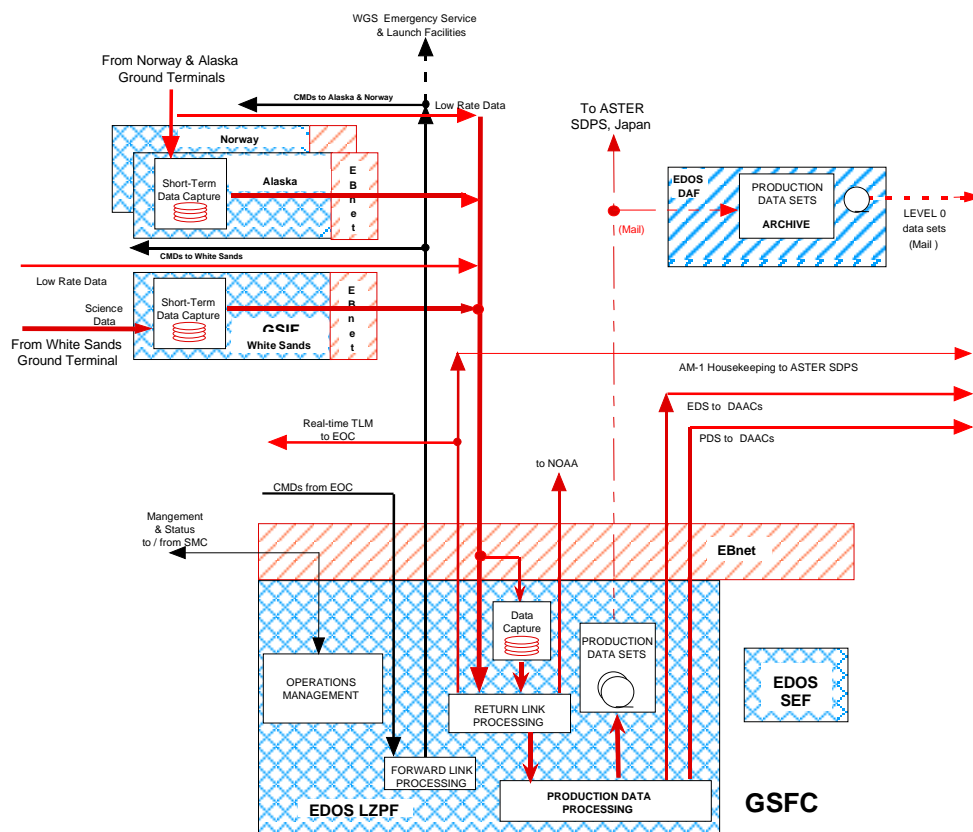
Note: GSIF at AGS and SGS to be installed Summer 2000.

Figure 5.4 EDOS Configuration

5.5.2 Data Capture

Data Capture functionality is provided at both the GSIF and the LZPF within EDOS. The GSIF provides a short-term data capture function where all high rate return link data are stored until the LZPF has confirmed

capture to protect against data loss during transmission to the LZPF. Data storage can be off-loaded to physical media for extended outage periods. The GSIF short-term capture function generates a catalog of all captured return link data by Spacecraft Contact Session (SCS) start and stop time and Physical Port ID. The GSIF forwards high rate return link data at a reduced rate to the LZPF for CCSDS processing.

The LZPF's Data Capture Function (DCF) provides for the capture of all low and high rate return link data received from the GSIF and ground terminals and for the replay of data for recovery processing and fault isolation. The DCF captures return link data independent of any return link processing on non-volatile physical media. The DCF generates a DCF catalog of all return link data received at the LZPF, identifying the data by Spacecraft Contact Session (SCS) or Return Link Service Session (RLSS) start and stop times, and SCS ID.

Control and coordination of replays from the DCF are scheduled by LZPF operations personnel. These replays are scheduled as necessary to support any recovery processing activity. The LZPF provides simultaneous support of replay of recovered data and high rate return link processing. The DCF provides retrieval of captured return link data for recovery processing concurrently with the capture of return link data from the GSIFs.

5.5.3 Data Quality Analysis

EDOS performs data quality analysis for all the return link telemetry and forward link commanding it processes. There are several levels of data quality information that are provided to EDOS external interfaces as either separate products or as annotations to telemetry products.

The GSIF Return Link Monitoring Function (RLMF) provides the capability to monitor the high rate return link quality and generate physical channel level statistics. These statistics are generated on data received on each physical channel through frame synchronization and error correction, then forwarded to the LZPF Operations Management Function (OMF). The LZPF includes their statistics in real-time reports to EGS elements and compares the GSIF statistics with statistics generated at the LZPF for the same data segment(s) in support of high rate data analysis.

The LZPF generates reports that are delivered to EGS elements in conjunction with data products delivered to them. During real-time data delivery operations, the LZPF generates a periodic Customer Operations Data Accounting (CODA) report. The CODA describes the operations activities of EDOS during an SCS and includes a snapshot of the data quality every 5 seconds. During data capture operations at the GSIFs, the LZPF receives these quality statistics from the GSIF for the high rate return link and incorporates these data into CODA reports, which also includes LZPF low rate processing statistics. The CODA reports are sent to the EGS elements nominally every five seconds. Following real-time and rate buffered data delivery operations and RLSS operations, an SCS Summary report indicating similar information for an entire SCS is sent to the appropriate EGS element. A separate RLSS Summary Report is also generated. CODA reports are sent to both the EOS Operations Center (EOC) and the ASTER Instrument Control Center (ICC).
For real-time and rate buffered data delivery services performed at the LZPF, an EDOS Service Header (ESH) is appended to each Service Data Unit which provides some quality indicators describing such things as source sequence count discontinuities, location of fill data within a packet, and Reed-Solomon error detection and correction results.

Quality and accounting information are included with each Production and Expedited Data Set created by EDOS, the information is appended to each particular data set and is known as a Construction Record.

Included in a construction record is information such as the volume of data in a data set, the quality of each packet, a list of all missing packets, the number of packets containing fill, the location of the fill data within each packet, the spacecraft start and stop time of the data set, and the ground (i.e., frame synchronization) start and stop time of the data set.

5.5.4 Data Processing

EDOS provides forward link processing of forward link data received from the EOS Operations Center (EOC), and provides return link processing for all return link data received from the TERRA spacecraft. Forward link processing consists of real-time processing of command data blocks (CDBs) received from the EOC. Services include the receiving, deblocking, logging, and cataloging of all forward link data received from the EOC. LZPF functions include generating, storing, and transferring status data including CDB discard notifications. The LZPF transfers the forward link data and provides the clock to the ground terminals for delivery to the EOS spacecraft.

There are four services associated with return link data processing: real-time return link processing, rate buffering, and production and expedited data processing. For the TERRA mission, real-time return link processing is performed on the low-rate housekeeping data and delivered to the EOC and the ASTER ICC. The result of this real-time processing are path service Consultative Committee for Space Data Systems (CCSDS) packets with ESHs appended describing the quality of each packet. Real-time return link data designated for real-time delivery are transmitted by the LZPF to the EOC and ASTER ICC at the same data rate at which the packets are received and in the same order as received. Data delay due to LZPF processing is minimized and consists of the latency resulting from the number of frames required to perform CCSDS service-related processing.

Rate Buffering provides for the delivery of return link data to appropriate EGS elements at a different, lower rate than the rate at which the return link data are received. For the TERRA mission, rate buffered data delivery is provided to the EOC for recorded housekeeping data, and to the NOAA for the CERES and MODIS instruments. The format of rate buffered data files are very similar to real-time data, namely, path service CCSDS packets with ESHs appended describing the quality of each packet.

Expedited data processing produces Expedited Data Sets (EDSs). For the TERRA mission, EDOS delivers EDSs to the GSFC and LaRC DAACs. An EDS contains either all packets from a single Spacecraft Identifier/Applications Identifier (SCID/APID) received during one SCS, or all packets from a single SCID/APID received during a single SCS with the secondary header quick-look flag set. Expedited data processing takes precedence over production data processing. Expedited data processing is similar to production data processing but does not include data merging. The volume of data that may be processed through expedited data processing is sized for two percent of the volume of data received over a 24 hour period. Expedited data processing demands in excess of two percent will be serviced; however, such requests may impact EDOS production data handling services. The packets used for expedited data processing are retained for production data processing. If the quick-look flag in the packet secondary header is used, the expedited processing is performed automatically, otherwise, a service request for a specific SCS must be made through the EOC. Service requests for specific SCSs to be expedited processed must be received by EDOS at least one hour prior to the start of the affected SCSs. Those SCSs may be defined in the following ways:

      a.   The first SCS following a given time of day (e.g., "first SCS following 0800 Universal Time, Coordinated (UTC)")

      b.   SCS scheduled start time

Expedited data sets can be requested after a SCS in special situations. EDSs are delivered from the LZPF to the appropriate DAAC within three hours after the receipt of data by EDOS, except for EDSs requested after the related SCS has been completed. It is assumed that DAACs are ready to receive EDSs when EDOS is ready to transmit.

The LZPF provides the production data processing capability which produces PDSs containing forward ordered CCSDS packets with summary quality and accounting data. Production data processing of return link CCSDS packet data is the process in which packets from one or more SCSs are sorted by APID, forward ordered by sequence counter, and quality-checked. A PDS, in which redundant packets are deleted and which includes quality and accounting summary information, is formed from the resulting packets.

Several processing options are available. These options are specified for each combination of SCID and APID by the EGS element and stored as part of operations management information maintained by EDOS. Each PDS contains only packets from a single SCID/APID, except for the PDSs specified in the ASTER ICD.

EDOS limits the time to accumulate data for any PDS to a maximum of 24 hours. Delays for production data processing are dependent on the timespan of the PDS. PDSs are nominally transmitted to the recipient prior to the generation of the next PDS for a given SCID/APID combination. EDOS may delay delivery of a PDS if the quality and completeness of the packets available for data set construction are below quality threshold levels.

PDSs are delivered to the GSFC and LaRC DAACs electronically via Ebnet; it is assumed that these locations are available at any time to receive data. The ASTER Science Data Processing Segment (SDPS) receives its PDSs via physical media.

5.5.5 Data Storage

The EDOS data archive provides the capability for long-term storage of all PDSs as a backup to the EGS DAAC archival storage systems. Prior to delivery of archive data to the DAF, archive data is staged at the LZPF for 30-60 days. The following sections describe the operations associated with the EDOS data archive: Archive physical media are stored in an environmentally controlled, secure facility. Physical media are tested periodically and reproduced as necessary to ensure data integrity and continued reliable storage. On a periodic basis, the data archive catalog is stored on physical media in the archive. DAAC to EDOS Data Sets (DEDSs) are received and stored on physical media from a DAAC to recover from lost or damaged PDSs. These DEDSs replace the impacted PDSs and are maintained in the archive in a similar manner as PDSs, with archive catalog links to identify the replaced PDSs.

Retrievals from the data archive are based on requests from DAACs. Requests for retrieval of archive data are made to the EDOS LZPF. Since the EDOS data archive provides a backup to the DAAC archive, retrieval requests are assumed to be infrequent. Retrieved PDSs are sent to the DAAC via tape in the same format in which the DAAC originally received the data. Requests for archive data are expected to be primarily on an instrument basis and based on PDS or DEDS-ID, time, APID, and SCID.

5.5.6 LZPF Operational Procedures

LZPF operational procedures are discussed in detail in Sections 5.5.6.2 through 5.5.6.7.

5.5.6.2 Science Downlink Schedule

The EDOS LZPF receives schedules electronically from the EOC. Schedules consist of User Schedule Messages (USMs), and a schedule could represent anywhere from one spacecraft event up to 2 weeks worth of spacecraft events. EDOS processes schedules received from the EOC, entering updates as appropriate and identifying conflicts, which are resolved as necessary by operations personnel from EDOS, EOC, and the Network Control Center (NCC) as required. Minutes prior to a scheduled spacecraft service for TERRA, the external scheduling information is used by EDOS to internally schedule the appropriate processing equipment at the GSIF and the LZPF necessary to support the contact. The schedule information is also used by EDOS, along with status data from the return link formatters describing frame synchronization status to help determine the loss of signal for return link telemetry and therefore the end of a spacecraft support session.

Data Capture

The LZPF DCF captures return link data independent of any return link processing on non-volatile physical media. The DCF provides data presence and status data for all data captured and retrieved. The DCF determines clock and data presence for SCS period determination and for fault isolation. Once configured, the DCF will automatically record data received.

Data Processing

Low Rate and High Rate Return link processing performed at the LZPF are data-driven activities in that data received are automatically processed based on information contained in the return link data and pre-established management information. The LZPF monitors each step in the return link processing sequence by collecting data quality and accounting information related to the processing, starting with the receipt of return link data through the transfer of the data to the EBNet interface. The LZPF OMF uses this information to account for data and resource utilization, generate reports, and identify and isolate faults.

Packet EDUs requiring real-time service are transferred to the requesting EGS elements and stored for post-SCS processing. Command Link Control Words (CLCWs) are extracted from CLCW Virtual Channel Data Units (VCDUs) and transferred in real-time with the source VCDU ESH to the EOC. During the real-time service processing, the LZPF collects processing status data, compiles the data into a CODA Report, and sends the report to the EOC and ASTER ICC every 5 seconds during the SCS.

In forward link data processing, Command Link Transmission Units (CLTUs) are received by the LZPF forward link processing service as command data blocks via EBNet and the source and format are validated.

Invalid command data blocks are identified and reported. All command data blocks are logged. Discarded command data blocks are reported to the EOC. Command data blocks identified as test data are routed back to the EOC.

Upon completion of the Return Link Service Session (RLSS), rate buffering service is provided for appropriate EDOS Data Units (EDUs) as identified by operations management data. File transfer protocol services are used for the rate buffering service, providing guaranteed delivery.

Production and Expedited Data Processing begins as soon as the data for the data set are completed. If data requires expedited processing, this processing is performed first. Expedited data sets (EDSs) are constructed on SCS boundaries. The Return Link Processor identifies data files for expedited processing. Expedited data processing begins immediately after the SCS or RLSS. The Production Data Processor creates an EDS construction record containing quality and accounting data, including data gap annotations, and includes it with each EDS. PDSs are constructed from all data contained within previously agreed upon boundaries (e.g., a SCS or a spacecraft start and stop time) and are merged into one file. Redundant data are deleted, with the best quality data retained for the PDS. The Production Data Processor creates a PDS construction record containing quality and accounting data, including data gap annotations, the PDS construction record is appended to the data set. Production data handling service transfers the PDS in files, using file transfer protocol services, that contains packets and file header and trailer quality and accounting data identified in the construction record. After an EDS or PDS file has been successfully transferred to either the GSFC or LaRC DAAC, the PDH service sends an EDS or PDS Data Delivery Record that relates to each data set transfer to the receiving EGS element. For the ASTER DAAC, EDOS records PDSs on physical media in files with quality and accounting data. Each physical media unit contains a PDS Physical Media Unit Delivery Record File, followed by a PDS Construction Record File and one or more PDSs. The PDS Physical Media Unit Delivery Record File identifies all the PDS(s) on the physical media unit. The PDS Construction Record File contains a copy of the PDS Construction Record for each PDS on the physical media unit. These construction records are stored in the same order as the PDS(s) are stored on the physical media unit. The PDS physical media is shipped along with a physical media delivery letter created from operator entries that identifies the PDS, shipping destination (EGS element) and shipping carrier.

Finally, PDSs are placed on physical media and placed in an archive staging area. PDSs can be read from the media and retransmitted to a DAAC. These physical media are transferred to data archive at the DAF after 30-60 days, where they are maintained for the duration of EOS plus 3 years.

Data Transfer

All data transfer operations are accomplished in EDOS via the EOSDIS Backbone Network (EBnet), using commercially available protocols. Real-time return link data transfers are performed using the Transmission Control Protocol/Internet Protocol (TCP/IP) protocol, minimal delay is introduced in the transmission of return link EDUs to the EOC and ASTER ICC.

Rate buffered, EDS, and PDS data transfers are performed using the File Transfer Protocol (FTP). All file transfers are performed via a "push" protocol by EDOS; EDOS initiates file transfers and assumes that all destinations are available 24 hours a day to receive data products. EDOS transfers signal files after the completion of the data set transfer to signal the end of an FTP session. Delivery Records relating to each data set transfer are sent to the appropriate destinations as well upon completion of each data set transfer.

Other Processing

The LZPF system support capability provides Integration, Test, and Verification (IT&V) and off-line fault analysis resources to support the verification of EDOS operational readiness and to ensure that system changes are correctly implemented and integrated.

The LZPF system support also includes tools to allow data analysis at all stages of processing as well as data editing and data dumps. This will allow for investigation of data anomalies. These tools are used to support LZPF functional and performance requirements testing, internal and external interface testing, and regression testing. Support tools include simulators, on-line recorders, analyzers, data analysis utilities, and the generation, import, and management of test data. Also, capabilities to monitor and log inputs, outputs, and intermediate points of the LZPF operational system support are also available to support system and data analysis and fault isolation.

Data Recoveries

Data recovery functionality is provided in EDOS by the Data Capture and Data Archive functions. The Data Archive provides PDSs on physical media to DAACs upon request to support any data recovery operations at these locations. Data is replayed from the LZPF Data Capture to support any reprocessing efforts within EDOS; reprocessing is typically performed only in rare instances and to correct defects which may have been present in previously delivered PDSs.

5.5.7 GSIF Operations

The GSIF provides the following capabilities for the handling of mission data:
<u>Short-term Data Capture:</u> All high rate return link data are stored until the LZPF has confirmed capture to protect against data loss during transmission to the LZPF. Data storage can be off-loaded to physical media for extended outage periods. The GSIF forwards high rate return link data at a reduced rate to the LZPF for CCSDS processing.
<u>Return Link Monitoring:</u> Statistics on link quality are generated at the physical channel level for high rate return link data. Except for monitoring, no return link processing is performed at the GSIF.

The Short-Term Capture Function (STCF) at the GSIFs provides for the capture of all high rate return link data. Data are forwarded to the LZPF at a reduced rate after each SCS for processing. This capture function also provides protection for EDOS or EBnet failures and for fault isolation. The STCF captures all high rate return link data received from the TGT. The STCF provides capture of all high rate data and generates a catalog of all captured return link data by SCS start time, SCS stop time, and Physical Port ID. The STCF provides status data for all of the data which it captures. Once configured, the STCF will automatically record data received. The STCF provides retrieval of captured high rate data for transfer to the LZPF on a non-interference basis with the capture of return link data. Data transfers to the LZPF are automatic or remotely controlled by EDOS operations personnel at the LZPF.

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The GSIF RLMF generates data on physical channel link quality, including
frame synchronization errors and losses, and Reed-Solomon error detection
and correction quality statistics.  These statistics are forwarded to the
LZPF every 5 seconds during an SCS, and are included in CODA reports
which are transferred to the EOC and ASTER ICC
```

5.5.8 Fault Isolation and Troubleshooting

EDOS is responsible for fault isolation and follow-up troubleshooting of the
Terra Ground System only. For TDRSS supported events these responsibilities
cover from the local area network (LAN) that connects FOT to EDOS, to the
input of the Low Rate Digital Switch (LRDS) at WSC. For EPGN supported events
these responsibilities cover from the FOT/EDOS LAN, to the i/o of the T-1 mux
at the ground station.

Three failover classes have been defined. These failovers are implemented to
restore service as quickly as possible: each class includes an estimated time
to of return to operations (ETRO). Since FOT has responsibility for overall

end-to-end coordination of realtime problems, EDOS recommends a failover to FOT. FOT confirms the failover to be implemented or directs otherwise. FOT is responsible for contacting the WSC Comm Services Controller (CSC) if necessary. The three failover classes are as follows:

Alpha Class Failover - a failover of the FOT/EDOS LAN. An alpha class failover should only be performed if the problem is with the EMOS system or the internal FOT/EDOS network. (ETRO is 1 to 2 minutes)

Bravo Class Failover - An internal EDOS system failover. Typically involves a failover of STPS. (ETRO is 1 to 2 minutes)

Charlie Class Failover - an EBnet data path failover (e.g. WSFB to WSFD). Involves FOT coordination with WSC Comm Services Controller (ETRO is up to 5 minutes)

Once the chosen failover has successfully been performed and the realtime service has been restored, troubleshooting efforts begin. EDOS is responsible for coordinating follow-up troubleshooting efforts with elements at WSC, EPGN and the NCC. The following chart illustrates the point of contact (POC) for troubleshooting during various mission periods for space network (SN) and ground network (GN) support:

Mission Period	POC - SN	POC – GN	POC-EPGS
Mission Testing	SNOM	GNOM	Wallops Test Engineer
Launch and Early Orbit	SNOM	GNOM	EPGS/Wallops Link Controller
Routine Ops	NCC PA	NCC PA	EPGS/Wallops Link Controller

Section 6.0 Mission Operations Support Elements

6.1 Flight Dynamics System (FDS) Overview

The FDS is a collection of workstations that host flight dynamics applications software required for supporting the EOS TERRA mission. The FDS is physically located within the EOC facility, and shares with EOC the facility-provided infrastructure such as electric power and communications network capabilities. The FDS will provide orbit, attitude, and maneuver capabilities. Orbit support will include generation of predicted and definitive ephemerides, support for the TDRSS Onboard Navigation System (TONS), and evaluation of the onboard navigation system. Attitude support will include all ground attitude determination, validation of onboard attitude determination and star ephemeris, and calibration of attitude sensors. Maneuver support will include generation of maneuver planning and calibration products.

6.2 FDS Interfaces

Figure 6-1, taken from the EBnet /FDS ICD, shows a simplified view of the interfaces between the EOC and FDS functional entities. Figure 6-2 shows the flow of FDS products and associated data between all involved parties. The FDS has eight workstations within the EOC facility: two HP/UX workstations (primary and backup); two SUN/Solaris workstations (primary and backup); two PC workstations (primary and backup); and two SGI workstations (primary and backup). The HP/UX workstation runs RTADS, generates planning aids and acquisition data, and performs attitude sensor calibration. The SUN workstation hosts the TONS Ground Support System (TGSS) for TERRA TONS support. The PC workstation provides maneuver planning support and generates predicted orbit data. The SGI workstation hosts real-time graphics displays of the spacecraft configuration, orbit and attitude. In addition, two EOC workstations will be located near the FDS workstations for use in monitoring real-time TERRA telemetry.

FDS Primary

HP

PC

SUN

Ethernet Hub

B32 FDDI Router

FDDI

B1 FDDI Router

CNE FDDI ISOLAN

CNE Router

CNE

FDF Open

B28

WOTIS

WFF

Ethernet

EOC Router

EOC

EOC Router

Primary RT Router

Backup RT Router

IONET/ NOLAN Router

IONET/ NOLAN Open

IONET/ NOLAN Secure Gateway

HP

PC

SUN

Ethernet Hub

FDS Backup

NCC

B3

IONET/ NOLAN Closed

WOTIS

WFF

FDF Closed

B28

FDS Primary

HP

PC

SUN

Ethernet Hub

B32 FDDI Router

FDDI

B1 FDDI Router

CNE FDDI ISOLAN

CNE Router

CNE

FDF Open

B28

WOTIS

WFF

Ethernet

EOC Router

EOC

EOC Router

Primary RT Router

Backup RT Router

IONET/ NOLAN Router

IONET/ NOLAN Open

IONET/ NOLAN Secure Gateway

HP

PC

SUN

Ethernet Hub

FDS Backup

NCC

B3

IONET/ NOLAN Closed

WOTIS

WFF

FDF Closed

B28

Figure 6-1. EOC/FDS Interface for EOS TERRA

79
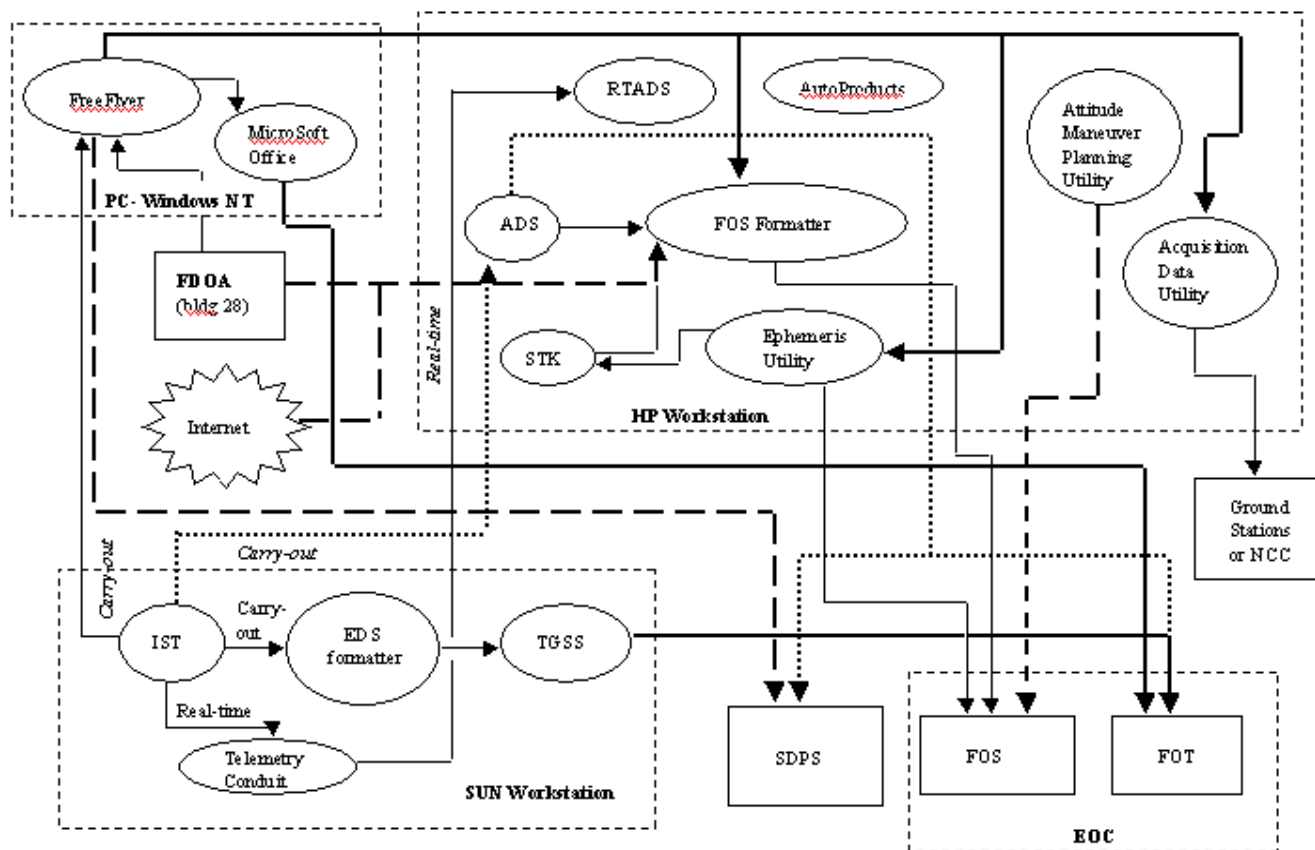
Figure 6-2. FDS Product Data Flow

MMFD: The Multi Mission Flight Dynamics (MMFD) area located in Building 28, formerly known as the Flight Dynamics facility (FDF), can access the FDS workstations via the EBnet interface (see Reference 6) for remotely using its workstations, but it has no direct interface with the EOC. The EBnet Router connects the EOC LAN and two other EBnet-provided LANs to which the FDS workstations are attached (prime FDS on one LAN, backup FDS on the other).

EPGN: The FDS provides acquisition data to Wallops Orbital Tracking Information System (WOTIS) via FTP, to be distributed by WOTIS to the Wallops, Svalbard, and Poker Flat 11 m antennas. This service will be provided on a regular basis so that data will be available in the event of a contingency.

NCC: The FDS provides acquisition data to the NCC via FTP for the 4 TDRS currently being used in the 4 FSW slots onboard TERRA. This interface is documented in Section 4.4 of 530-ICD-NCCDS/MOC.

EMOS: The FDS provides products (P&S and table load input) to EMOS for ingest. This interface is documented in the FDS/ECS ICD, 552-FDD-96/010R0UD0.

FOT: The FDS provides some products directly to the FOT without passing them through FOS. This interface is documented in the FDS/ECS ICD, 552-FDD-96/010R0UD0.

6.3 Operations

During Launch & Early Orbit (L&EO), Flight Dynamics Analysis Branch/Code 572 and Mission Analysis Branch/Code 583 personnel will operate the FDS. Once EOS TERRA reaches its mission orbit and enters the routine operations phase, operation of the FDS will be transitioned to FOT control. Flight Dynamics personnel will be available for consultation in the event of a contingency.

The call sign to reach the lead FDS operator is "FDS".   Phone numbers and pager numbers are posted in the EOC at the FDS workstations.

Section 7.0 Space Network

7.1 Introduction

TERRA will utilize the TDRSS Space Network and associated institutional support to provide forward (command); return (telemetry) links and tracking data to be used in orbit determination.

7.2 Operations Concept

The Space Network (SN) shall provide two 25-minute contacts per orbit to support the Ku-Band and S-Band downlinks of Terra high rate science data at 150 Mbps and S-Band recorded data at 256 kbps respectively. Nominally, the first contact will be used to downlink Ku-band data and the second contact will be used to downlink the recorded S-Band housekeeping data. The SN shall provide the first 25-minute contact 100% of the time. If the high rate data is not successfully downlinked during the first contact (i.e., due to something other than SN schedule availability), the second contact will be used to bring it down. For the second event, the SN shall provide up to a 25-minute contact for recovery of the 256 kbps S-band data.

The Space Network will also provide the following personnel in support of the Terra launch and early orbit support. A Space Network Operations Manager (SNOM) to monitor overall space network operations, a TDRSS Networks Operations Manager for the expendable launch vehicle, and the NISN Mission Communications Manager. Other support will be provided by Multi Mission Flight Dynamics (MMFD), Nasa Integrated Services Network (NISN), White Sands Complex (WSC) and NCC personnel.

In addition, the NCC will provide the retention of configuration codes, link performance and communication and statusing of ground configuration message requests to the WSC on a request basis.

7.3 General

Information in this section provides procedures that are necessary for support of the TERRA mission.

7.3.1 Network Control Center

The Network Control Center (NCC) is the focal point for management of the Space Network (SN), which consists of the NCC and White Sands Complex (WSC)

7.3.1.1 NCC-Specific Mission Positions

The Operations Control Room (OCR) is the NCC contains mission-unique positions. These positions are manned only during mission support periods (or as needed).

7.3.1.2 Mission Manager (MM)

The Mission Manager (MM), Code 450 is a NASA position that serves as the Networks and Mission Services Project authority assigned to a specific mission.

7.3.1.3 Technical Manager (TM)

The Technical Manager (TM) is the senior contractor position in the NCC, and is responsible for the supervision of the NCC contractor effort and for maintaining consistent operational integrity between the NCC and STDN support facilities.

7.3.1.4 Performance Analyst (PA)

A Performance Analyst (PA) is assigned to TDRS-East, -West, and Spare, and is the NCC position responsible for monitoring real-time support performance, validating performance standards, assisting the NCC controllers in rapid failure identification, and restoration of services. The PA conducts all SN playbacks. The PA performs the Acquisition/ Tracking Controller (AT) functions when the AT position is not staffed.

7.3.1.5 Space Network Operations Manager (SNOM)

The Space Network Operations Manager (SNOM) is a NCC position responsible for ensuring optimum use of STDN capabilities committed to supporting each mission project. The SNOM is the focal point for coordination and implementation of operational procedures required to provide expected network support. Under the direction of the MM, the SNOM is responsible for implementing operational procedures, controlling the STDN configuration, and coordinating the performance of all STDN pre-mission and mission support. The SNOM also supports the Terra Test Manager (TERRA-TM) for pre-mission test activities. The SNOM is responsible for implementing all network testing or simulation activities and is also responsible for ensuring all mission and/or functional test requirements are accomplished in accordance with the ground rules outlined in the test plan, procedure, and Briefing Message (BM). The NOM submits TDRSS Anomaly Reports (TARS) for all testing.

7.3.1.6

7.4 NCC Support Positions and Areas

7.4.1 Data Base Manager

The Data Base Manager (DBM) is a position staffed 8 hours per day, 5 days per week. The DBM is the NASA position responsible for the implementation and maintenance of the NCC SN operational databases. The DBM interfaces with SN users and SN element databases to incorporate changes and updates. For further information concerning the DBMs operational functions and responsibilities, refer to the NCC Database WEB site at: http://defiant.gsfc.nasa.gov/~jgroom/code5342.html.

7.4.2 Data Base Administrator

The Data Base Administrator (DBA) is the NCC point of contact for coordinating data base requirements. The DBA responds to the technical direction of the NASA DBM. The DBA is responsible for maintaining a library of current databases, restoring databases, data input into the data base (as directed), troubleshooting, and maintaining database documentation for the NCC.

7.4.3 Forecast Analyst

The Forecast Analyst (FA) is a forecast scheduling position within NCC Scheduling. The FA is responsible for coordinating future scheduling requirements with SN users, maintaining schedule-related data base information, maintaining the forecast data base, monitoring and interacting closely with the SO, analyzing scheduling resource problems and potential scheduling conflicts, and providing alternative solutions to SN users.

7.4.4 Scheduling Operator

The Scheduling Operator (SO) is staffed 24 hours per day, 7 days per week. SO is responsible for coordinating real-time scheduling requirements with SN users, analyzing scheduling resource problems and potential scheduling conflicts, and providing alternative solution to SN users.

7.4.5 Documentation

Documentation (DOC) is staffed 8 hours per day, 5 days per week. DOC is responsible for the control, status, and procedural verification of Teletype changes for all operational documentation after incorporation and issuance into the STDN documentation system. DOC controls and issues the numbers for all numbered

teletype control messages, Requests for Information or Clarification (RIC), ISI, STDN Network Directives (SND), and other messages issued by the NCC.

7.4.6 SN Position Call Signs
a. GSFC NCC:
1.   Network Director ND
2.   Technical Manager TM
3.   Network Operations NCC Ops Manager (SN) (point-of-contact)
5.   Scheduling Operator NCC Scheduling
6.   Performance Analyst NCC PA
7.   Forecast Analyst Forecast Scheduler
b. WSC:
1.   Communication Service Controller WSC CSC
2.   Operations Supervisor WSC Ops Sup

7.5   NCC Operational Interface Procedures for TERRA

The NCC provides management of resources for scheduling, controlling, and monitoring the performance of the STDN. This function includes coordinating the control of available network resources, schedule processing, conflict resolution, emergency scheduling, networks testing, performance monitoring/fault isolation, acquisition data dissemination, and data base maintenance. In addition, the NCC is responsible for support of launch and real-time orbital operations, operational interfacing with TERRA EOC, and ground configuration control. The NCC interface is defined in 451-OIP-NCC/STDN Users (formerly 534-OIP-NCC/STDN Users).

The transmission of ISI 001 will initiate the mission status period and place the network on TERRA mission status. The network will remain on mission status until an ISI is sent to terminate mission status.

7.6 Scheduling Procedures

The interface for scheduling between the NCC and TERRA EOC is provided by NISN. Interface protocol and interface message formats are documented in the Interface Control Document between the Network Control Center Data System and the Mission Operations Centers, 530-ICD-NCCDS/MOC. The operations interface procedures are documented in 451-OIP-NCC/STDN Users (formerly 534-OIP-NCC/STDN Users).

7.7 Fault Isolation Procedures and Monitoring

7.7.1 Guidelines

a. The NCC will coordinate all operational real-time fault isolation when a SN problem is identified or suspected. Real time is defined as that period 5 minutes prior to scheduled event start time (T-5) to event termination.

b. The SN element discovering, or becoming aware of, a real-time operational problem, should immediately notify the Communications Services Control (CSC) at the White Sands Complex (WSC).

7.7.2 SN Fault Isolation

a. Purpose. This procedure establishes the guidelines for resolving problems that may occur during an event's support.

b. Participants
      1. NCC.
        (a) PA.
        (b) TM.
      2. WSC.
      3. TERRA EOC.

c. Procedure. The PA is responsible for coordinating fault isolation. The following guidelines are used:
      1. The NCC may at any time initiate an investigation of a SN problem so long as mission support is not affected.
      2. The user may not troubleshoot a problem after it has been established as a SN anomaly unless requested by the NCC to assist in problem resolution. If the user is not willing to accept limited/degraded support, it will release the service to the NCC for problem resolution.
      3. The NCC has the capability at all times to configure or reconfigure the network; however, changes to the SN configuration are not made during mission support without notifying the user.
      4. Users will be advised only that service will be available/unavailable for the period in question. They will not be informed of any specific equipment/system failure.

7.7.3 Spaceflight Tracking and Data (STDN) Anomaly Reporting

During all scheduled events that utilize the TDRSS and which are on the operational schedule, in the event that there is an anomaly with the scheduled service, a STDN Anomaly Report will be completed by the NCC Performance Analyst. This report will detail the anomaly with a description i.e. Telemetry, Command, or Tracking service.

After completion, the report will be given to the STDN Anomaly Committee for disposition. At the next meeting of the committee, the report will be reviewed and provided to the TERRA/EOC for response.

The response from the TERRA/EOC will provide the necessary information that will determine the source of the anomaly i.e. TERRA/EOC, NISN, TDRSS and if the anomaly was caused by software, hardware, procedure etc.

Complete details of this procedure are located in Network Control Center and Spaceflight Tracking and Data Network Station Interface Procedures (532-SIP-NCC/STDN V2) Revision 1.

7.8 NCC Data Base Information

7.8.1 Service Specification Codes

A Service Specification Code is a set of fixed and reconfigurable parameters that define a single service for a given SN user. Service Specification Codes must be resident in the NCC and TERRA EOC databases prior to the start of interface testing. The MOSP is the controlling document for TERRA service specification codes. Any changes to these codes must be made in accordance with paragraph 5.10.2.

7.8.2 Procedures

The TERRA EOC will submit a Data Base Change Request (DBCR) to the MSM/DSM, who will verify that the request meets, approved SN support commitments. The MSM/DSM will complete and forward the DBCR to the SN DBM containing the minimum information, as follows:

From: MSM/DSM (or user POCC for non-routine). To: SN DBM. Info: POCC (routine requests). MSM/DSM (non-routine requests). ATSC Evaluation/Documentation Unit (EDU) ARO-4 (all requests). NCC NM (all requests).

1. Subject: NCC data base change request.
2. SIC: 1873 (TERRA)
3. Type Change: _____ (routine or non-routine).
4. Data base subset to be changed: _____ (e.g., configuration code, spacecraft characteristics record, NISN scheduling parameters, etc.).
5. Service Specification code or prototype event ID with SUPIDEN: (refer to pre-mission operation planning documents where applicable).

6. Parameters to be changed in NCC:
   A. Parameter name: _____ (e.g., maximum data rate, data channel configuration, receiver configuration, etc.).
   B. Channel: _____ (I, Q, 1, 2, or 3).
   C. Parameter values; from _____, to _____.
      (Note: repeat A, B, and C for each parameter to be changed.)

7. Requested implementation date: _____ (year, month, date time Z).
   8. Additional clarifying remarks: _____ (as appropriate).
   9.   Release authority: _____ NOTE Insert NA (not applicable) in items that do not apply.

7.8.3 Database Change Request

On receipt of a DBCR, the SN DBM will determine if other SN elements are affected by the change. If applicable, the SN DBM will issue a Data Base Change Instruction (DBCI) to the affected elements.

7.8.4 Verification and Acknowledgement

When a SN element receives a DBCI from the SN DBM, the affected element Data Base Controller (DBC) will initiate local processing procedures to implement and validate the database changes. Upon completion of implementation processing, the affected element will send a verification and acknowledgement message to the SN DBM. Initial acknowledgement may be sent verbally for real-time data base changes; however, written documentation must follow.

7.8.5 Data Base Change Notice Procedure

When the SN DBM has received acknowledgement of implementation and validation of Database changes from all affected elements; the SN DBM will transmit a database Change Notice (DBCN) to the affected SN users and the MSM/DSM, indicating to all Addressees that a requested data base change has been implemented.

7.9   White Sands Complex

The White Sands Complex (WSC) processes, monitors, and routes data flowing between WSC and the EOC/MOC. WSC also uses magnetic tape recorders to record data that exceeds the data rate capabilities of the communication link, spacecraft data in the event of communication link/line failures, spacecraft data for systems/data link reliability studies.

7.9.1 Ground and SN System

The WSC ground station has the capability for constant communications with each of the orbiting TDRS's, as well as a full complement of simulation and verification equipment for all users. The WSC consists of the WSGT and STGT located in White Sands, New Mexico, as well as the Guam Remote Terminal located in GUAM. WSC ground station consists of independent Space-to-Ground Link Terminals (SGLT); standalone TDRS S-band Tracking, Telemetry, and Command systems (STTCS), along with associated subsystems; and data recording and transport capabilities. Each SGLT consists of forward and return links/equipment chains to process command, telemetry, and tracking data for a TDRS and customer spacecraft simultaneously. Three SGLTs are located at STGT, two at WSGT and one at GRT that is remotely operated from the WSGT.

7.9.2 WSC Services

WSC will provide the forward link (for command), return link telemetry, and tracking
services for the TERRA spacecraft.

7.9.3   SN Procedures

Procedures for defining and obtaining SN support and describing how a user flight project interfaces with functional elements of the GSFC MO&DSD are provided in the Space Network (SN) User's Guide. The operational aspects of TDRSS use are found in the Performance Specification for Services, TDRS, S-805-1, Revision B..

7.10 Detailed Support Definition

7.10.1   TDRSS Service Use

TERRA uses MA SSA and KSA TDRSS services to support the command, telemetry, and science data transfers. In addition, both coherent two-way range and Doppler (and noncoherent one-way Doppler) tracking services are used to support orbit determination, transponder frequency trend analysis, and other related functions.

7.10.2   End-to-End Test Services

There are two types of End-to-End Test (EET) service capabilities available. The user has the capability of scheduling either type of EET service through the NCC. ODM's to the NCC and User Performance Data (UPD) to the POCC are available for both types of tests provided the NCC schedules the test events.

a. The DIS EET provides for data to flow into and out of the ground terminal to simulate users forward and return services through TDRSS. For DIS EET test events, the simulated data stream paths must originate external to WSC. The following types of reconfigurations are available during DIS EET services: OPM-02, reacquisition's (for return services only); OPM-03, user reconfigurations; and OPM-11, Doppler Comp Inhibit Request.

b. The local EET is conducted locally at the ground terminal. PN test data streams are generated locally, flowed through the TDRSS system and terminated on site. The results of the LOCAL EET are verbally reported to the NCC. There are no reconfiguration capabilities during local EET services.

7.11 Applicable Documents

The following documents provide detailed Space Network information:

1. *STDN Operations Concepts*, 532-OCD-STDN, Revision 4, November 1996.
2. *Network Control Center (NCC) Standard Operating Procedures*, Volumes 1and 2 532-SOP-NCC/V1 and 532-SOP-NCC/V2, Revision 1, June 1997.
3. *NASA Communications Operations Procedures (NASCOP),* 542-006, Volume 1, Revision 2, January 1992, and Volume 2, Revision 2, September 1995.
4. Mission Operations and Data Systems Directorate (MO&DSD) *document Space Network (SN) Users' Guide (SNUG), 530-SNUG* (formerly STDN No. 101.2),Revision 7, dated November 1995.
5. *Network Control Center Data System (NCCDS) Detailed Requirements*, 530-DRD-NCCDS (formerly STDN No. 203.13/NCCDS), dated November 1993.
6. Interface Control Document Between the Network Control Center Data System and the Mission Operations Centers, 530-ICD-NCCDS/MOC, dated April 1996.

Section 8.0 Wallops Flight Facility

8.1 Introduction

Wallops Flight Facility (WFF) manages three ground stations being used by EOS-AM1: the 11-M Alaska Ground Station (AGS) at Poker Flat, Alaska; the Svalbard Ground Station (SGS) in Norway; and the Wallops Ground Station (WGS) at Wallops Island, Virginia. The AGS and SGS stations are also referred to as the EOS Polar Ground Stations (EPGS). WOTIS provides the scheduling interface for all of the ground stations. All sites provide up and down S-band links. The AGS and SGS also provide X-band science data receipt. AGS, SGS, and WGS interface directly with the EOC.

8.2 Station Support

The WFF command and telemetry requirements are listed in Table 8-1. These requirements will be used to support pre-launch testing and checkout, early orbit, and normal and emergency operations. While SN provides primary ranging, WFF provides Doppler Range Rate capability for backup tracking.

From any of the WFF-managed sites, S-band telemetry, which includes both real-time and playback data, is transferred in real-time to the EOC. All commands and S-band telemetry are transmitted over a closed NISN-provided network. X-band science data received at the AGS/SGS are recorded then sent to the Earth Science Data and Information System (ESDIS).

Site	Frequency Band	Link Frequency (MHz)	Function	Bit Rate	Format/ Modulation
WGS	S-band Uplink	2106.40625	Command	2 kbps	NRZ-M/PSK/PM
	S-Band Downlink	2287.5	Tracking RT TLM SCC Dump Stored PB	16 kbps 16 kbps 512 kbps	Bi-Φ-S/PSK/PM Bi-Φ-S/PM
AGS SGS	S-band Uplink	2106.40625	Command	2 kbps	NRZ-M/PSK/PM
	S-Band Downlink	2287.5	Tracking RT TLM	16 kbps kbps	Bi-Φ-S/PSK/PM
			SCC Dump Stored PB	16 kbps 512 kbps	Bi-Φ-S/PM
	X-band Downlink	8212.5	DP Science PRBS	75/75 Mbps	NRZ-M/SQPSK

Table 8-1. EPGN Stations Command and Telemetry Requirements

8.3 Station Configuration

Station functional block diagram is shown in Figure 8-1.
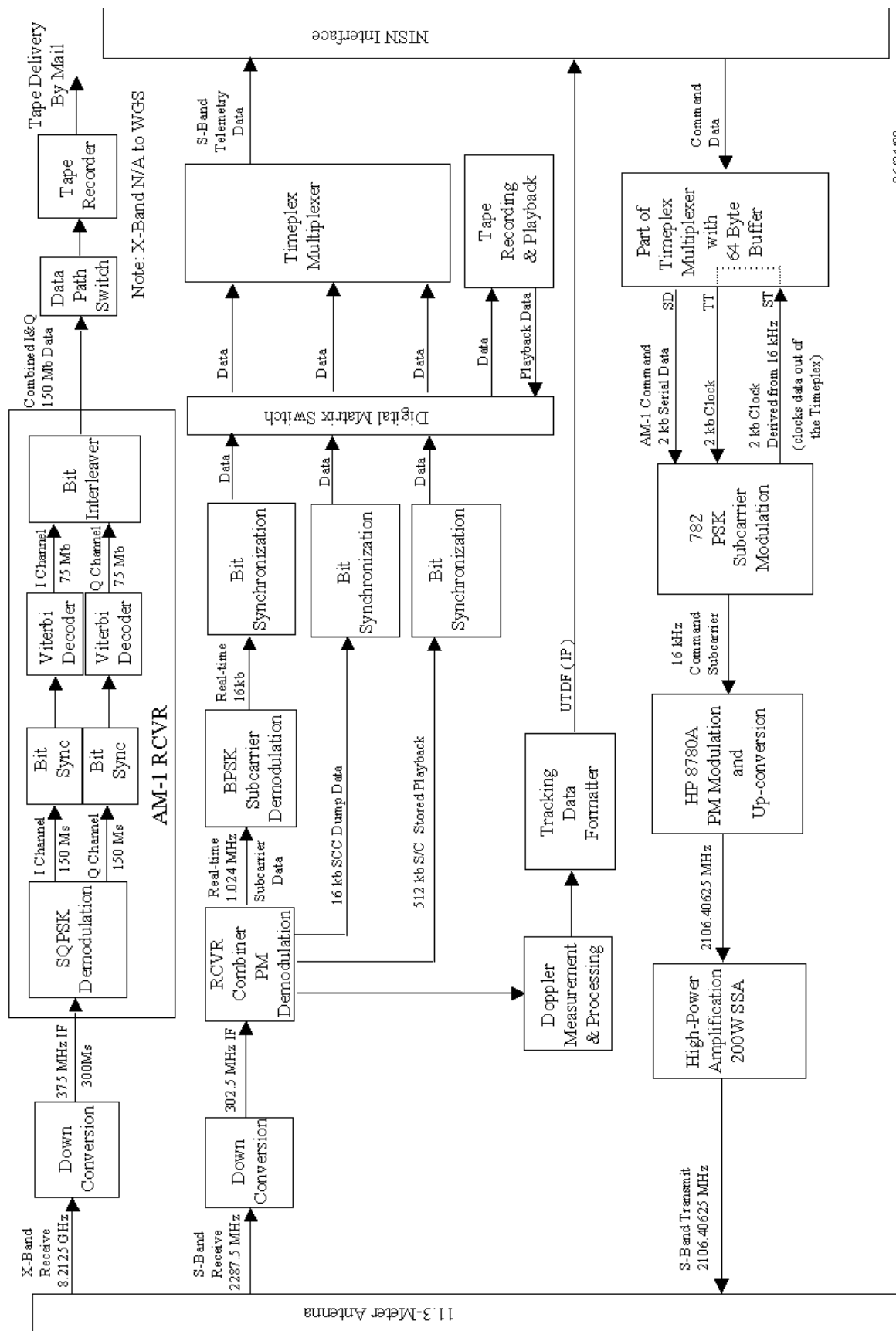
Figure 8-1   TERRA EPGS Functional Diagram

8.4   Points of Contact

a. WGS: Thomas   B.   Gross,   WGS   Operations   Supervisor
                    telephone: 757-824-1778
                    fax: 757-824-2403
                    e-mail: Thomas.B.Gross.1@gsfc.nasa.gov

b. WOTIS: Deborah   L.   Dukes,   Wallops   Scheduling   Group   (WGS)
                    (757) 824-2186 or 1774 (8:00 a.m. to 4:30 p.m. Eastern Time, Mon -
                    Fri.)   or   (757)   824-2375   all   other   times.
                    fax: 757-824-2403
                    e-mail: Deborah.L.Dukes.1@gsfc.nasa.gov

c. Wallops Link: telephone: 757-824-2375
                    Controller fax: 757-824-2403

8.5 Tracking

The WFF-managed stations shall provide support for collection of non-coherent and coherent S-band tracking data by generating one way and two way Doppler tracking data.

8.6 Telemetry

8.6.1 General

The WFF stations receives digital telemetry data from the spacecraft using the S-band downlink for real-time and playback data, and the X-band downlink for real-time or playback science data.

8.6.2 S-band Downlink Link Parameters

a. Downlink Frequency: 2287.5000 MHz.

b. Carrier Telemetry Data Rates: 16.0 kbps (SCC Dump) &

                                 512.0 kbps (Playback).

c. Carrier Modulation: Bi-Φ-S/PM (SCC Dump & Playback).

d. Carrier Modulation Index: (SCC Dump & Playback). 1.0 +/- 0.05 radians square wave, 5.35 dB carrier suppression, .09 dB Carrier to Sideband Ratio

e. Subcarrier Frequency: 1.024 MHz (Real-Time House-Keeping).

f. Subcarrier Telemetry Data Rate: 16.0 kbps (RT H/K).

g. Subcarrier Modulation: Bi-Φ-S/PSK/PM (RT H/K).

h. Subcarrier Modulation Index: (RT H/K)   0.8 +/- 0.04 radians sine wave 1.45 dB carrier suppression, 7.21 dB Carrier to Sideband Ratio

i.   Polarization: Right Hand Circular (RHCP).

Mode	Link #	Polarity	Data Rate		Mod.	Tracking
			Subcarrier	**Carrier**		
Real-Time Only	10A	RHC	16.0 kbps	N/A	PSK/PM	Doppler R/T
SCC Dump	10B	RHC	16.0 kbps	N/A	PSK/PM	Doppler R/T
Stored Playback	10C	RHC	16.0 kbps	512.0 kbps	PSK /PM & PCM/PM	Doppler

Table 8-2. Spacecraft Telemetry Downlink Modes

Activity Code	Receive/ Record	Command	Tracking Data	Data Forwarding Mode
TR1	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	2 kbps	2-way/ Coherent	16.0 kbps 16.0 kbps 512 kbps 150 Mbps
TR2	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	None	1-way No Uplink Carrier	16.0 kbps 16.0 kbps 512 kbps 150 Mbps
TR3	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	2 kbps	1-way/ Uplink Carrier On S/C Mode Non-Coherent	16.0 kbps 16.0 kbps 512 kbps 150 Mbps

Note: Each TR codes supports all telemetry modes, the activity codes vary with uplink configurations.

Table 8-3. Site Activity Codes

8.6.3 X-band Link Parameters (N/A WGS)

    a.   Downlink Frequency: 8212.5 MHz.

    b.   Carrier Telemetry Data Rate: I Channel=75 Mbps/ Q Channel = 75 Mbps.

    c.   Carrier Modulation: NRZ-M/ SQPSK.

    d.   Carrier Modulation Index:

    e.   Polarization: RHCP

8.6.4 X-Band Characteristics

Mode	Link #	Data Mode	Antenna/ Polarization	Data Rate (Mbps)		Modulation	Frequency (MHz)
				I	Q		
1	1	PRBS	DAS(RHC)	75	75	SQPSK	8212.5
5	2	DP Science	DAS (RHC)				

8.7 Command

8.7.1 General

The WFF stations shall transmit commands at 2 kbps to the spacecraft.

8.7.2 Command Parameters

RF parameters for TERRA are as follows:

    a.   Command Data Rate   2 kbps

    b.   Subcarrier Frequency   16 kHz +/-0.001% (The 2 kbps Command Data Bit Clock will be coherent with the 16 kHz subcarrier.)

    c.   Modulation Signal Type   NRZ-M

    d.   Carrier Modulation   Phase Modulation, 0.7 radian +/-10% (1.10 dB carrier suppression)   (8.56 dB Carrier to subcarrier ratio)

    e.   Uplink Center Frequency   2106.40625 MHz +/- EPGN to Terra Doppler Shift

f.	AGS/SGS/WGS Antenna Diameter	11.3 Meters
g.	Spacecraft Antenna Polarization	RHCP (Omni)
h.	AGS/SGS/WGS Minimum EIRP	97.0 dBm

8.8 Equipment Profile/Configurations

8.8.1 Support Requirements

a. SA 11m Antenna S-Band and (AGS and SGS X-Band)

b. Tracking Data Formatter (TDF)

c. 7715 Bit Synchronizers

d. GDP Frame Synchronizers (Manually configured)

e.

f. Metrum BLVDS Recorders

g. PSK Demodulator (Manually Configured)

h. Apogee Labs Mux/Demux (Manually Configured)

i. Subcarrier Generator, GDP 782 (Manually Configured)

8.8.2 Master Node

8.8.2.1 Work Station

IP addresses are purposely omitted from this document for Network Security reasons.

8.8.2.2 Antenna Requirements

a. SA 11m

b. Setup Time: 420 Secs

c. Start   0 Secs

d. Stop: 0 Sec

e. CONFIG 34: TR1 (Coherent command support, 2W)
35: TR2 (No Uplink, 1 Way)
36: TR3 (Non-coherent support with Command Uplink, 1 Way)

8.8.2.3 Support Definition

a. Satellite ID: AM1

b. TR Code: 1, 2, or 3 as scheduled

c. Operation: Scheduled Support

8.8.2.4 Automated Tracking Station

a. Station ID: WLPS, AGS, or SGS as applicable

b. Pass Results Reporting:

c. Recipient Ftp Profile: WOTIS_Host

d. Destination: wotrsfts/awots/in

e. File Prefix: PRFW

f. Shipping Recipient Prefix: SIFW

8.8.2.5 UTDF Recipients

a. Recipient#1 FTP Profile: Flight-Dynamics A

b. Destination Directory: /pub/tdh

c. Recipient#2:   n/a

d. Destination Directory: n/a

8.8.2.6 Automated Antenna

a. Name: AGS =   , SGS =   , WGS = SA 11m #1

b. Type: SA 11 meter

c. Number of monitored instruments: 20

d. ID: AGS =   , SGS =   , WGS = 11

e. Schedule Destination: /disk2/home/aaas/etc/remote

f. Config Source: /disk2/home/aaas/etc/log/reports

g. Pass Log Source: /disk2/home/aaas/ect/log/reports

h. Tape Log Source: /disk2/home/aaas/etc/log

8.8.3 Equipment Settings

8.8.3.1 Metrum Blvds Recorders Units #1/#2

a. Automatically Write File Marks: On

b.	Auto Eject:	On
c.	Detect File Marks:	On
d.	Operating Mode:	Word & Streaming
e.	Tape Length:	T-120
f.	Direct:	Off
g.	Label:	1
h.	Record Data Rate:	16000000
i.	Desired Buffer Threshold:	193
j.	Directs:	Off
k.	Number of Blocks:	0
l.	Dubbing:	Off
m.	Reproduce Data Rate:	16000000
n.	Desired Buffer Threshold:	55
o.	First PBN:	1
p.	Last PBN:	2
q.	Dubbing:	OFF
r.	File Mark:	0
s.	Format:	Ten Gig/ with Buffered ?
t.	Setup:	120 Seconds
u.	Start:	12
v.	Stop:	10

8.8.3.2 PSK Demodulator **AGS&SGS 329A (Realtime 16 kb data; Unit Number Site Option)**

a. (TR1, 2, & 3)

  1. Subcarrier Frequency: $1.024 \ \times 10^{6}$

  2. Input Source: 1

  3. Loop BW: $2.0 \ \times 10^{1}$

  4. Data BW: 9.6×10^{4}

  (**PSK Demodulator 3329 (WGS)**

1. Loop BW: 2.0×10^2

2. Data BW: 4.8×10^4

8.8.3.3 Bit Sync Units

a. Real-time 16 kbps and SCC Dump 16 kbps data (Units site option)

  1. Bit Rate: 1.600×10^4 (TR1, TR2 & TR3)

  2. Loop BW: 0.30%

  3. Input Code: BiΦ - S

  4. Input Pol: NORM

  5. Detector: INTEGRATE $ DUMP (grey)

  6. Impedance In: LO (50 Ohms)

  7. PN Mode: Off

  8. Input Source: S0

  9. Output Code 1:   NRZ-L

  10. Output Code 2: NRZ-L

  11. FEC Rate: ½

  12. FEC Format: Off

  13. Setup Time: 180

  14. Start: 5

  15. Stop: 4

b. Stored Playback 512 kbps data Unit # Site Option)

  1. Bit Rate: 5.12×10^5

  2. Loop BW: 0.30%

  3. Input Code: Bi-Φ-S

  4. Input Pol: Normal

  5. Detector: INTEGRATE $ DUMP (grey)

  6. Impedance In: LO (50 OHMS)

7. PN Mode: Off

8. Input Source: S0

9. Output Code 1:   NRZ-L

10. Output Code 2:   NRZ-L

11. FEC Rate: ½

12. FEC Format: OFF

13. Setup Time: 180

14. Start: 5

15. Stop: 4

8.8.3.4   Frame Synchronizer GDP 225D (WGS only)

(Not SW Controlled At This Time) All Modes, Same Settings

8.8.3.4.1   Frame Sync

a. CCSDS Transfer Frame Length: 2048 bits (256 bytes)

b. Sync Pattern: 1ACFFC1D00000000

c. Sync Pattern: FFFFFFFF00000000

d. Sync Polarity Correction: Auto

e. Search Check Errors: 0

f. Lock Errors: 0

g. Check Pattern: 0

h. Lock Pattern: 0

i. Window: 0

j. Sync Pattern Word: First

k. Data Input Polarity: Normal

l. Input Source: CH1

m. Input Code: NRZ-L

8.8.3.4.2   Subframe Sync

a. Recycle Pattern: 000000001ACFFC1D

b. Recycle Mask: 00000000FFFFFFFF

c. Subframe Sync Type: Recycle

d. ID Counter: MSB First

e. Frame Counter Start: 0

f. End: 511

g. Counter Direction: Up

h. First Subframe Sync Pattern Bit: 0

i. Sync Pattern Length: 32

j. Search & Lock Errors: 0

k. Lock Errors: 0

l. CheckPattern: 1

m. Lock Pattern: 0

8.8.3.5 Tracking Data Formatter Set-up

a. Site ID: AGS=   , SGS=   ,WGS=511

b. Support ID: 1873

c. Vehicle ID: 1

d. Uplink Frequency: 2106.40625 MHz

e. Transmit Pad ID: AGS=29, SGS=30, WGS= 64

f. Receive Pad ID: AGS=29, SGS=30, WGS= 64

g. Doppler Mode: 2 way (TR1) , 3 way (TR2) , 1 way (TR3)

h. MDDF: Off

i. High Speed UTDF: Off

j. Low Speed UTDF: On

k. Setup Time: 90 seconds

l. Start: 7 seconds

m. Stop: 8 seconds

8.8.3.6 Carrier Doppler Measurement System

Manually configured.

a. L.O.: Internal

b. Polarization: RHC

c. Simulator: HALT

d. 10 ppm Mark LED: LIT

e. 5 MHz Ref LED: LIT

f. Rcvr L.O.: LIT

g. Loop Lock Mix Mult Quad LED: LIT

h. Status: RHC

8.8.3.7   APOGEE LABS MUX/DEMUX

a. Demux In: Line-TTL

b. Signal Monitor: N/A

c. Control: Local

d. Composite Rate: 4Mbps

e. Activate New Software: Base

8.8.4   SA 11M Configuration

8.8.4.1   S-Band Tracking Receiver

a. RF Frequency: 2287.5 MHz

b. P-Band-Tuner: 302.5

c. 1ST IF BW: 6 MHz

d. 2ND IF BW: 3.3 MHz

e. Gain Control Mode: AGC

f. AGC Time Constant: 100 mSec

g. 2nd LO Source: AFC/APC

h. 2ND LO VFO Offset: 0.000 kHz

i. Signal Strength Det: ENV AM

j. Signal Strength Offset: 0.0000 Volts

k. Slope: 20 dBm/volt

l. Carrier Indicator: 3dB

m. Demod: PM/BPSK

n. SIG STR. Outputs: 1 (J16) POL + 2 (J17) POL +

8.8.4.1.1   Tracking Receiver Demod

a. Video BW: 2000 kHz

b. Video Attn: As Required

c. Video Monitor OUTPUT: 1

d. Video Coupling: AC

e. Video Polarity: 0 Degs

8.8.4.1.2   Demod #1 BPSK/PM

a. Demod Mode: PM

b. Loop BW: 1 kHz

c. Search Mode: Auto

d. Search Range: 150 kHz

e. Search Offset: 0.0000 kHz

8.8.4.1.3   Demod #2 FM

N/A

8.8.4.2   Track Diversity Combiner

a. Pre Detection Mode: COMBINED

b. Post Detection Mode: COMBINED

c. Pre Detection BW: 300 Hz

d. Pre Detection Range: 5 kHz

e. Pre Detection Demod: PM/BPSK

f. Post Detection Video: 0

g. 2ND LO Source: AFC/APC

h. 2ND LO Offset: 0.0000 kHz

8.8.4.2.1   Video Demod

a. Video BW: 2000 kHz

b. Video Attn: 0 dB

c. Video Monitor: OUTPUT 1

d. Video Coupling: AC

e. Video Pol: 180 Degs

8.8.4.2.2   Demod #1 BPSK/PM

a. Demod Mode: PM/BPSK

b. Loop BW: 1 kHz

c. Search Mode: Fast

d. Search Range: 150 kHz

  e. Search Offset: 0.0 kHz

8.8.4.2.3 Demod #2 FM

N/A

8.8.4.3 Data Receivers

  a. RF Frequency: 2287.5 MHz

  b. P-Band-Tuner: 302.5000 MHz

  c. 1ST IF BW: 6 MHz

  d. 2ND IF BW: 3.3 MHz

  e. Gain Control Mode: AGC

  f. AGC Time Constant: 100 mSec

  g. 2nd LO Source: EXTERNAL

  h. 2ND LO VFO Offset: 0.0000 kHz

  i. Signal Strength Det: ENV AM

  j. Signal Strength Offset: 0.0000 Volts

  k. Slope: 20 dBm/volt

  l. Carrier Indicator: 3.0000 dB

  m. Demod: PM/BPSK

  n. Sig Str. Outputs: 1 (J16) POL + 2 (J17) POL +

8.8.4.3.1 Data Receiver Demod

  a. Video BW: 2000 kHz

  b. Video Attn: As Required

  c. Video Monitor: OUTPUT 1

  d. Video Coupling: AC

  e. Video Polarity: 0 Degs

8.8.4.3.2 Demod #1 BPSK/PM

  a. Demod Mode: PM

    b.   Loop BW: 1 kHz

    c.   Search Mode: Auto

    d.   Search Range: 250 kHz

    e.   Search Offset: 0.0000 kHz

8.8.4.3.3   Demod #2 FM

N/A

8.8.4.4   Data Diversity Combiner

    a.   Pre Detection Mode: COMBINED

    b.   Post Detection Mode: COMBINED

    c.   Pre Detection BW: 1 kHz

    d.   Pre Detection Range: 5 kHz.

    e.   Pre Detection Demod: PM/BPSK

    f.   Post Detection Video: 0

    g. 2ND LO Source: AFC/APC

    h. 2ND LO Offset: 0.0000 kHz

8.8.4.4.1   Video Demod

    a.   Video BW: 2000 kHz

    b.   Video Attn: As required

    c.   Video Monitor: OUTPUT 1

    d.   Video Coupling: AC

    e.   Video Polarity: 0 Degs

8.8.4.4.2   Demod #1 BPSK/FM

    a.   Demod Mode: PM

    b.   Loop BW: 1 kHz

    c.   Search Mode: Auto

    d.   Search Range: 150 kHz

    e.   Search Offset: 0.0 kHz

8.8.4.4.3   Demod #2 FM

N/A

8.8.4.5   S-Band Select Configuration

a. Band: Low

b. Synthesizer Frequency: 124.0625 MHz

8.8.4.6   ACU Configuration

a. Auto Track Parameters: Auto Diversity X-S Band

b. Polarization: S-Band RHC Transmit

c. S-Band Transmit: Enable Config 34,36 (TR1 & TR3)/ Disable Config 35 (TR2)

d. Exciter Select: Site Option Normally 1

e. Pedestal Power :   Enable

f. Feed Power: Enable

8.8.5   Uplink

8.8.5.1   HPA

a. System: On

b. Mode: Operate

c. Atten: 40 dB

8.8.5.2   Command Echo Control/Status

a. Offset Source: S-Band RHC Track

8.8.5.3   Exciter Configuration

a. Uplink Source: Data

b. Mod Index Attn: (Setting required to achieve 1 radian uplink mod index *)

c. Exciter Select: Site Option (Normally SIG GEN 1)

d. Frequency: 2106.406250 MHz

e. Power Output: 5.0000

f. RF Out: ON

g. Sweep Function: OFF (software enabled with carrier)

h.   Sweep Width: 160.0000 kHz

i.   Sweep Rate   10.0000 kHz/sec

- Mod index attenuator settings determined by site during mission test Automatic Acquisition:

a. 8.8.5.4 GDP 782 Subcarrier GeneratorInput: TTL/BYPASS

b. Ref: INT

c. CX: LOC

d. Output Level J11:   6 Vpp

e. Mod Type: BYPASS

f. Out: SIN

g. Div.:   8

h. SC Freq.:   00016000

i. Mod.:   COHO

j. CLK.:   COHO

8.8.5.5 Uplink Control Unit

a. Uplink Command Local Remote: Remote

b. Test Data Channel Local Remote: Remote

c. Channel Select Local Remote: Remote

d. Uplink Attenuation: (Settings required to achieve 1 radian uplink mod index*)

e. Input Level J1:   6 Vpp

f. Test Attenuator   30 dB

8.8.5.6 Automatic Acquisition Mode

a. Configuration 34:   Coherent

b. Configuration 35:   Disabled

c. Configuration 36:   Non-coherent

8.8.6 X-Band (N/A WGS)

8.8.6.1 X-Band Tracking Receiver

a. RF Frequency:.   8212.5 MHz

b. Synth. Frequency: 134.250 MHz

c. 1ST IF BW: 6.0 MHz

d. 2ND IF BW: 12MHz

e. Gain Control Mode: AGC

f. AGC Time Constant: 100mSec

g. 2nd LO Source: AFC/APC

h. 2ND LO VFO Offset: 0.000 kHz

i. Signal Strength Det: ENV

j. Signal Strength Offset: 0.000 Volts

k. Carrier Indicator: 3.0000 dB

l. Demod: PM/BPSK

8.8.6.2 X-Band Video / Demod

1. Video

  a. Video Bandwidth: 1000 kHz

  b. Video Attenuation: 0 dB

  c. Video Monitor: OUTPUT1

  d. Video Coupling: AC

  e. Video Polarity: 0 Degs

2. Demod 1 BPSK/PM

  a. Demod Mode: BPSK?

  b. Loop Bandwidth: 1 kHz

  c. Search Mode: AUTO

  d. Search Range: 150 kHz

  e. Search Offset: 0.0000 kHz

8.8.6.3   Demod #2

.Not Used

8.8.6.4 X-Band Data Path Switch

Target Channel:	Source Channel:	Target Channel:	Source Channel:
BER RCVR	BER Transmitter	Output Port 8	X Band Data 2
HDDR 1	HDDR 1	Output Port 9	X BAND DATA 3
HDDR 2	HDDR 2	Output Port 10	X Band Data 4
HDDR 3	HDDR 3	Output Port 11	Input Port 11
HDDR 4	HDDR 4	Output Port 12	Input Port 12
HDDR 5	HDDR 5	Output Port 13	Input Port 13
HDDR 6	HDDR 6	Output Port 14	Input Port 14
Output Port 7	X Band Data 1	Output Port 15	Input Port 15

8.8.7 T/R Code Descriptions

Activity Code	Receive/ Record	Command	Tracking Data	Data Forwarding Mode
TR1	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	2 kbps	2-way/ Coherent	16.0 kbps 16.0 kbps 512 kbps 150 Mbps
TR2	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	None	1-way No Uplink Carrier	16.0 kbps 16.0 kbps 512 kbps 150 Mbps
TR3	16.0 kbps on 1024 kHz Subcarrier 16.0 kbps Baseband 512 kbps Baseband 150 Mbps X-Band (except WGS)	2 kbps	1-way/ Uplink Carrier On S/C Mode Non- Coherent	16.0 kbps 16.0 kbps 512 kbps 150 Mbps

8.8 Voice Procedures

TBD

8.9 Scheduling

8.9.1 General

The EPGS stations are a shared resource and utilize the Wallops Scheduling Group (WSG) to coordinate external project support requests and produce a conflict free schedule for each station. WSG shall coordinate scheduling of all uplink and downlink services required AGS, SGS and WGS. WSG shall also receive, process, and integrate acquisition data received from the EOC into the composite schedule product used to schedule each ground station. The scheduling strategy maximizes coverage gaps with the WFF-managed sites.

8.9.2 Schedule Request

During on-orbit operations, the FOT will receive inview files from the Flight Dynamics System (FDS). The FOT will filter the inview file and then create a Schedule Request file. This file is sent to WOTIS three weeks before the target week. The file is transferred via ftp to WOTIS and is deposited into the AM1/In directory or as a backup can be sent via email to the Wallops Scheduling Group.

8.9.3 Forecast Schedule

WOTIS will de-conflict the request and provide the FOT with a conflict free Forecast Schedule approximately 2.5 weeks before the target week

8.9.4 Update Schedule

The FOT has the option of deleting or changing passes one week before the target week by sending an updated schedule file to WOTIS. The Updated file is only needed if a change is required. It is sent to the same directory at WOTIS as the Schedule Request file.

8.9.5 Confirmed Schedule

WOTIS will provide the Confirmed Schedule to the FOT to confirm the supports which the EPGS has scheduled, and is a final verification of the Update Schedule or Schedule Request. The EOC will provide WOTIS with 48 hours worth of X-band and S-band downlink contacts times on a daily basis. The X-band contact schedule covers a 48 hour period and is updated every 24 hours. The remaining 24 hours

are utilized as a contingency period. The Daily schedule files will be placed in the WOTIS directory using ftp.

8.9.6 Daily Schedule

When necessary the FOT will provide WOTIS with updated or contingency X-band and S-band downlink contacts times on a daily basis. The X-band contact schedule will cover a 48 hour period and will be updated every 24 hours. The Daily schedule files will be placed in the WOTIS directory using ftp.

8.9.7 Acquisition Data

The Station Acquisition data file covers a 48 hour period and is updated daily. The Acquisition files will be placed in the appropriate WOTIS directory using ftp as agreed upon by FDS and Wallops.

8.10   Recording Procedures

8.10.1   X-band Data

X-band data received by AGS and SGS are recorded and the tapes are shipped 48 hours after recording, even if the tape is not full. The stations will make duplicate copies of the X-band tapes prior to shipment and retain copies until tapes have been released by a Tape Acknowledgement Report sent to WOTIS.

All X-band tapes will be shipped to:

NASA

Goddard Space Flight Center

Building 32 Room S29

Greenbelt, MD. 20771-001

Mailstop 430.1

Attention: Rose Wood

EDOS Operations Suoervisor

The tape shipment notification will include the Airway Bill Number and include an e-mail to: edosops@pop500.gsfc.nasa.gov with a CC copy to: rwood@pop500.gsfc.nasa.gov.

8.10.2   S-band Contingency

EPGS stations record S-Band telemetry and hold the tapes for 72 hours, unless the EOC requests longer retention for specific occasions. In the event of a contingency, such as a real-time transmission outage, the EOC may initiate a playback of telemetry from the ground station. Playback is scheduled at a

mutually acceptable time through the Wallops Scheduling Group (WSG), or the Wallops Link Controller when the WSG is unmanned.

The EOC requests a contingency playback from an EPGS station by telephoning the WSG or the Wallops Link Controller. The EOC provides AOS/Start and LOS/Stop times of the data to be retransmitted. For unmanned stations, retransmissions from tape will normally occur during the next shift when personnel are available.

8.11 Station Reports

The EPGS and WGS stations will provide the following reports to the EOC:

a. Real-time Status.   For X- and S-band data, RF equipment status information is provided by the ground stations. For S-band data, additional information is provided by the front end at the supporting station. Real-time status data sent to the EOC via TCP/IP.

b. Downlink Summary Report. Following every support taken at a ground station, statistics are collected from various hardware and software station components. These data are transmitted to WOTIS, where they are stored and used in the generation of a downlink summary report which is subsequently transferred to the EOC.

c. Tape Shipment Report. When tapes containing X-Band data are shipped from the AGS and SGS to the EDOS, a report is sent electronically to notify the EDOS that the tape(s) are en route and can be expected within the normal shipping time of a few days. This report is sent via open networks.

d. Anomaly Report. EPGS stations will notify the Wallops Link Controller of any anomalies and station reconfigurations. Wallops Link Controller will notify the TERRA EOC/FOT Operations Controller by voice of the anomaly and transmit a free-form problem report within 24 hours listing the anomaly and any corrective measures taken since the anomaly was detected, including the Estimated Time of Return to Operations (ETRO). If the anomalous condition occurs during the station's unmanned hours of operation, and is deemed severe enough to cause the stations not to support, the MOC will immediately call the Wallops Link Controller and request on-site assistance.

8.12   Initial Acquisition Procedures

8.12.1   Normal Acquisition

a. Automated configuration file parameters are resident in SCC database and specified by TR code.

Coherent Mode   (AUTO)

Sweep Rate: 10 KHz/Sec

Sweep Range: 160 KHz (+/- 80 KHz)

Offset: 45 KHz

b. At Carrier up-time system is at Uplink CF [2106.40625 MHz] - 45 kHz Doppler offset frequency sweeping +/- 80kHz at 10 kHz per second rate.

c. The following sequence is automated without operator intervention:

1. Schedule Transfer from WOTIS at scheduled AOS minus 8 minutes if Ephemeris and Schedule agree.

2. System control computer (SCC) will Start Pre-pass activities at scheduled AOS –2.5 minutes.

NOTE

Any operator intervention during this period will most likely result in lost pass.

(a) Activities: Zero receivers on noise.

(b) Position Train axis, Elevation axis, and Azimuth Axis to predicted intercept point (IP).

(c) Turn on HPA and set attenuation.

3. At Scheduled AOS time:

(a) Track Cmd. initiated: Axis will move along Program Track.

(b) Elevation Axis clears masking. (Time Variable.)

(c) Carrier Up, Sweep enabled. (Only after Masking is cleared).

(d) Receiver Lock: Lock time is variable, but will usually occur within 8 seconds (.5 [one half] Doppler range) of RF Carrier up. Lock time could be as long as 16 seconds or full sweep before Coherent Acquisition.

NOTE

Receiver lock is attained when downlink signal strength is 6 dB above receiver noise floor [configuration file threshold parameter] or stronger. After lock is attained, system goes from program track to autotrack.

(e) RX Local Oscillator (L.O.) and TX Freq within Specified Range which causes the Transmit Sweep to be disabled. Starting a (Uplink frequency) decay to center Frequency + (current)Doppler offset value. Typically 8 seconds for decay process.

(f) Uplink Modulation is now enabled once CF + Doppler is reached (Receiver L.O. frequency = CF and Doppler offset).

(g) Uplink frequency decays from CF + Doppler to CF or 2106.40625 MHz taking approximately 44 seconds to settle.

(h) Total time from Carrier Up to "Go for Command" is typically between 1 minute and 1 min. 16 seconds.

4. Loss of Signal will occur when: The antenna enters masking at which time the Uplink Carrier + modulation is disabled.

8.12.2   Non Coherent Acquisition Mode

Sweep Rate: 10 kHz/Sec

Sweep Range: 160 kHz (+/- 80 kHz)

a.   Same process as 8.12.1 c. 3. (a) - (f) with exception of steps d. and e., "Receiver acquisition not required" (TR code specified).

b.   Uplink will sweep for 47 seconds. Settle for 44 seconds.

c.   Go for command approximately 1 minute 31 seconds after carrier turn on.

8.12.3   Blind Acquisition

Used when the spacecraft transponder downlink is disabled. Uplink/Command functions are same as Non-Coherent Mode. At completion of the uplink acquisition procedure station announces, "Go for command in the blind." The project will send the command to enable the transponder downlink.

8.12.4   Side Lobe Track

a.   Operator will disable Auto-Track.

b.   Attempt to acquire main lobe by using Time Bias Functions to peak the Receiver AGCs.

c.   Re-Select Auto-Track.

8.13.5   Receiver False Lock

Operator will break lock on the Receiver and re-lock on the carrier.

8.13.5   Re-acquire Coherent Mode

a.   Operator will select SWEEP ON from the SCC GUI. Allow the Transmitter to sweep until coherency is indicated by the correct Doppler offset or observes the Rx and Uplink carrier sweeping in coherency.

b.   Operator will select STOP SWEEP and observe the sweep decay process until "Go For Commanding" is determined.

8.13.6 Up-Link Carrier Hand Over.

All handovers are a manual process requiring voice contact with project or pre-scheduling (non-WOTIS /automated).

a.   To another Station:

    1. From the ACU screen on the SCC the Operator will select Transmitter Disable button at the prescribed time.

    2. The operator will observe a momentary Receiver drop while the SC transponder captures the other uplink. Should a false lock occur, refer to paragraph 8.12.3.

b. Hand-over from another Station:

    1. At the prescribe time –1 sec, The operator will select Transmitter on and enable Sweep.

    2. Observe mission power is being radiated.

    3. If coherent mode is enabled, determine coherency by observing Doppler and Uplink/Downlink sweeping in coherency.

    4. Allow two full sweeps of the uplink carrier then turn sweep off. Allow for settle, then give project "Go for Commanding".

Section 9.0 NISN

9.1   Serial clock/data service requirements will be supported on the NISN/EBnet dedicated serial clock/data interfaces, including the links to all the ground stations and the launch site at VAFB. See diagram 1.

9.2   Level 0 Science processing requirements supported on NISN Mission IP network.. See diagram 2.

9.3   Non-level 0 Science Processing requirements supported by the NISN Standard IP network. See diagram 2.

9.4   NISN will be providing all voice services as required to support Terra. See diagram 3.

9.5   See Trouble Reporting Procedures.
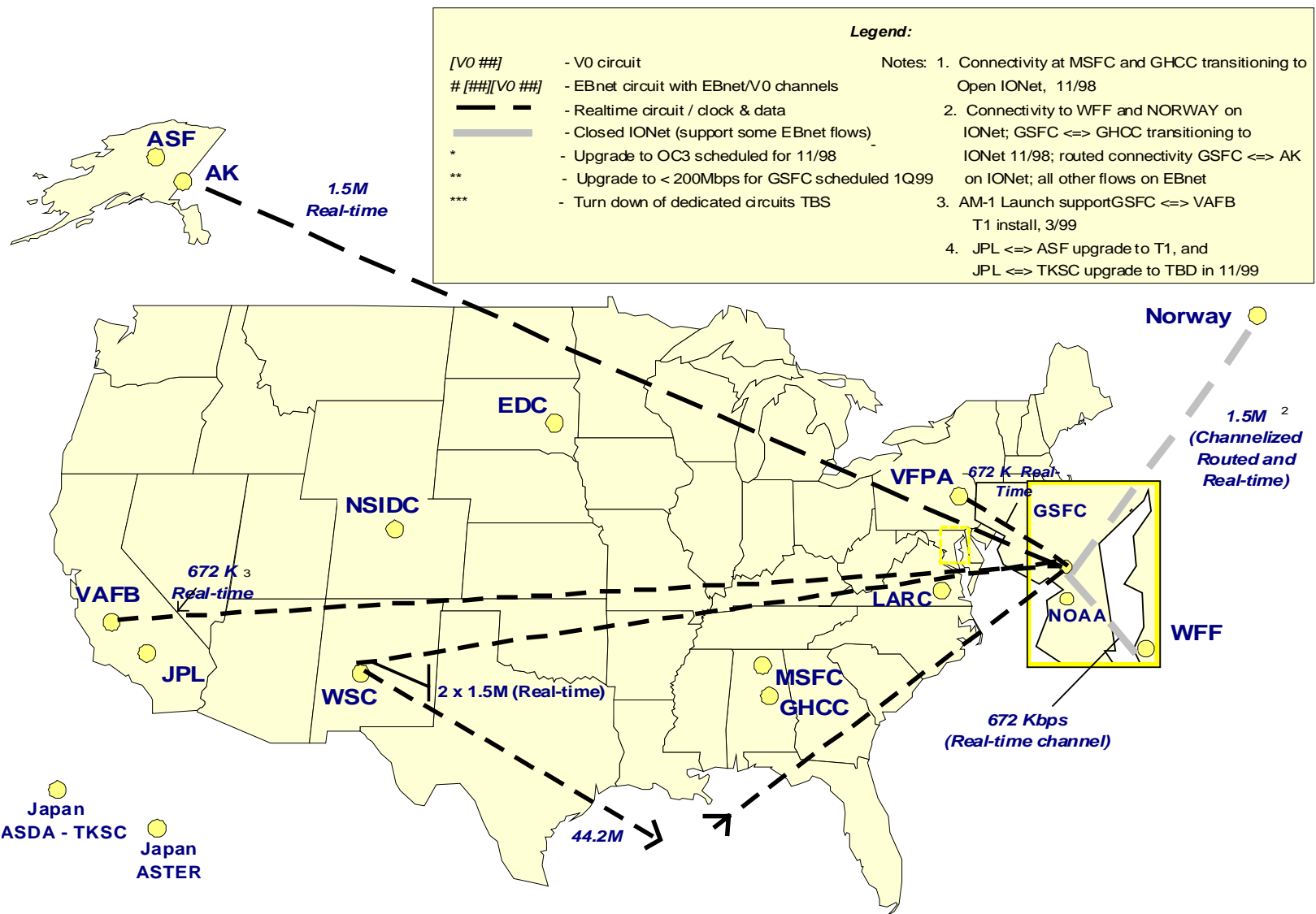
Diagram 1 Serial Clock/Data Services

Diagram 2 Level 0 Science Processing Services.

Legend:

[V0 ##]   - V0 circuit
[##][V0 ##]   - EBnet circuit with EBnet/V0 channels
                 - Realtime circuit / clock & data
                 - Closed IONet (support some EBnet flows)
*   - Upgrade to OC3 scheduled for 11/98
**   - Upgrade to < 200Mbps for GSFC scheduled 1Q99
***   - Turn down of dedicated circuits TBS

Notes:
1. Connectivity at MSFC and GHCC transitioning to Open IONet, 11/98
2. Connectivity to WFF and NORWAY on IONet; GSFC <=> GHCC transitioning to IONet 11/98; routed connectivity GSFC <=> AK on IONet; all other flows on EBnet
3. AM-1 Launch support GSFC <=> VAFB T1 install, 3/99
4. JPL <=> ASF upgrade to T1, and JPL <=> TKSC upgrade to TBD in 11/99

9.2 EBnet Configuration

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Diagram 3 Terra Launch & Mission Voice Configuration
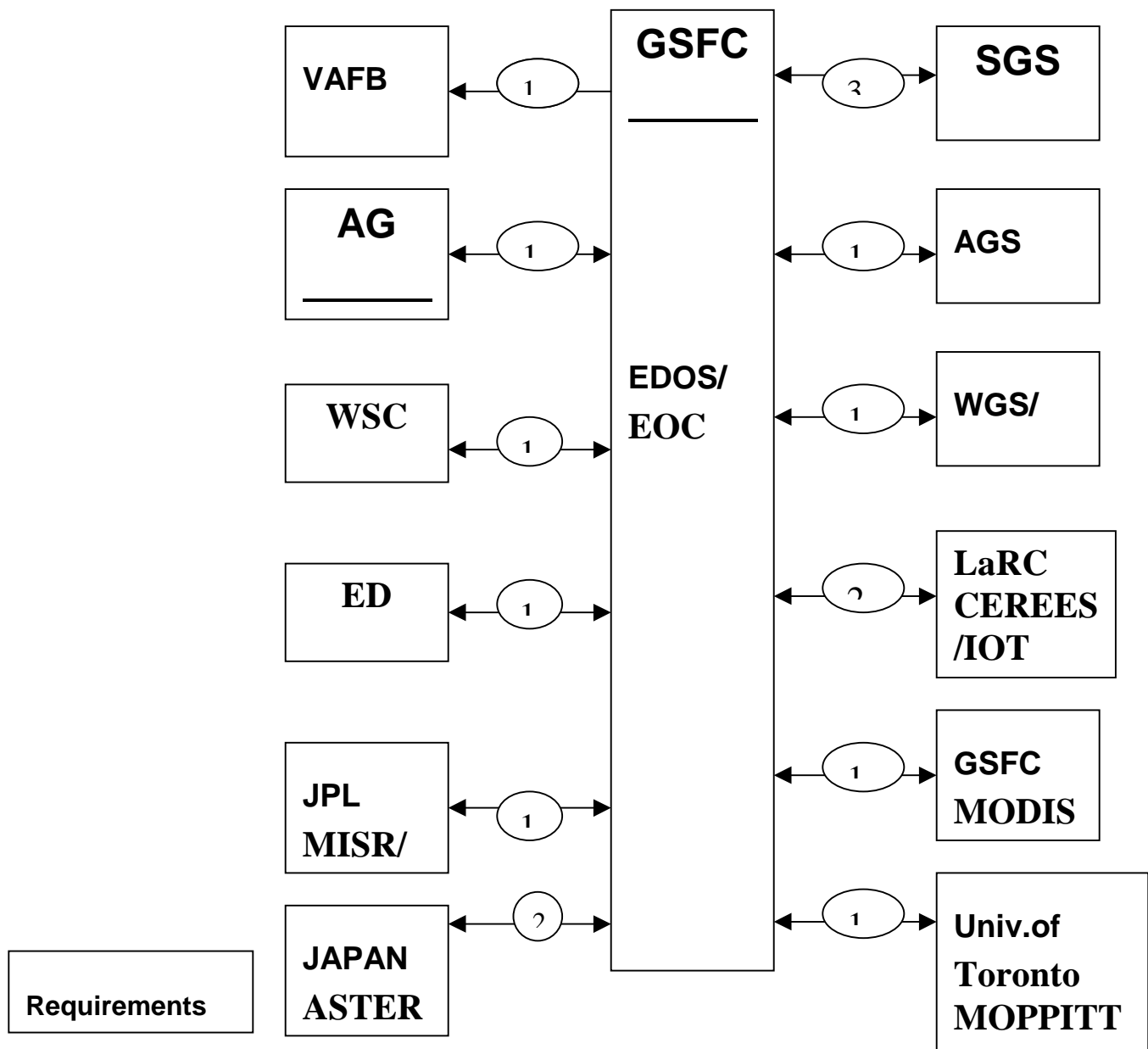
1. GSFC/VAFB - 5 voice circuits
2. GSFC/AGS- 1 voice circuit
3. GSFC/WSC - 1 voice circuit
4. GSFC/EDC - 1 voice circuit
5. GSFC/JPL(MISR/IOT) - 1 voice circuit
6. GSFC/SGS - 3 voice circuits
7. GSFC/LMVF - 6 voice circuits
8. GSFC/WOTS - 1 voice circuit
9. GSFC/LaRC(CERES/IOT) - 1 voice circuit
10.GSFC/(MODIS/IOT) - 1 voice circuit(local)
11. GSFC/Univ. of Toronto(MOPPITT/IOT)
    1 voice circuit

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9.5   Trouble Reporting

Service User identifies/recognizes communications service problems

User reports problem:

> Mission – Network Operations Management Center: 301-286-6141
> Science – NISN Information Support Center: 256-544-1771

User identifies interface experiencing trouble, including:

> Type of Interface: Routed or Clock & Data
> If Routed:
> > Source and Destination IP addresses
> > Multicast group, if applicable
> If Clock & Data
> > Source and Destination locations
> > Data Channel (e.g., I Channel)
> Describe problem (e.g., no data, corrupted data, when first noticed, history, etc.)
> Contact names and phone numbers at Source and Destination

Appendix A
APPLICABLE DOCUMENTS

Appendix B

EOSDIS Related World Wide Web Sites

These URLs are for additional information as required. This list is current as of November 1999.

URL	Project	Description of URL,what_it_is
ftp://eos.nasa.gov/	ESDIS, DAACs	EOS FTP server
ftp://eos.nasa.gov/EosDis/Daacs/Docs/	ESDIS, DAACs	DAAC documentation area
ftp://eos.nasa.gov/EosDis/Daacs/Docs/DaacsOfEosdis/	ESDIS	DAACs of EOSDIS
ftp://eos.nasa.gov/EosDis/Daacs/Docs/Governing/	ESDIS, DAACs	Governing documents
ftp://eos.nasa.gov/EosDis/Daacs/Statistics/	ESDIS DAACs	SCRS reports and tables for FTP retrieval
ftp://eos.nasa.gov/EosDis/uswg/	ESDIS DAACs	USWG area
ftp://eospso.gsfc.nasa.gov/docs/Kennel_Report.pdf	EOS	Kennel Report
ftp://eospso.gsfc.nasa.gov/docs/initial.pdf	EOS	Flights of EOS platforms and instruments (graphic)
ftp://eospso.gsfc.nasa.gov/docs/measurements.pdf	EOS	24 EOS measurments
ftp://ftp.hq.nasa.gov/pub/cio-office/Exc-Notice/	NASA CIO	Chief Information Officer notices; a FTP site with Word files
http://DAAC.GSFC.NASA.GOV/CAMPAIGN_DOCS/UARS_project.html	GSFC	UARS page
http://arbs8.larc.nasa.gov/sage3/	LaRC	SAGE, Stratospheric Aerosol and Gas Experiment, site at Langley
http://asd-www.larc.nasa.gov/ceres/ASDceres.html	LaRC	CERES web site (Clouds and the Earth's Radiant Energy System) (at Langley)
http://asterweb.jpl.nasa.gov/	AM-1	ASTER site at JPL, Advanced Spaceborne Thermal Emission and Reflection
http://bernoulli.gsfc.nasa.gov/EBnet/	EOSDIS	EBnet home page
http://cmdm.east.hitc.com/baseline/	ECS	ECS Baseline
http://cne.gsfc.nasa.gov/index.html	GSFC	CNE
http://daac.gsfc.nasa.gov/	ESDIS	Goddard Distributed Data Archive

URL	Org	Description
		Center
http://daac.gsfc.nasa.gov/TECHNICAL/y2k/gdaac/	DAAC	GSFC DAAC Y2K page
http://dao.gsfc.nasa.gov/	NASA Code 910	Data Assimilation Office
http://dial.gsfc.nasa.gov/	ESDIS	Data and Information Access Link
http://dmserver.gsfc.nasa.gov/ecsdev/gui/html/acronym_finder/	ESDIS	acronyms
http://ecsinfo.hitc.com/	ECS	ECS Information
http://edcwww.cr.usgs.gov/landdaac/	ESDIS	EROS Data Center
http://edcwww.cr.usgs.gov/landdaac/sir-c/sir-c.html	EOSDIS	SIR-C/X-SAR (Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar)
http://edhs1.gsfc.nasa.gov/	ECS	ECS Data Handling
http://eos-am.gsfc.nasa.gov/	AM Project at GSFC	EOS AM home page
http://eos-chem.gsfc.nasa.gov/hirdls.html	HIRDLSat GSFC	HIRDLS page
http://eos.acd.ucar.edu/mopitt/home.html	MOPITT	MOPITT site, at UCAR
http://eos.nasa.gov/	ESE	EOS home page
http://eos.nasa.gov/eosdis	EOSDIS	Earth Observing System Data and Information System (EOSDIS)
http://eos.nasa.gov/esdis	ESDIS	Earth Science Data and Information System (ESDIS)
http://eos.nasa.gov/imswelcome	ESDIS	V0 IMS
http://eos.nasa.gov/uswg	ESDIS DAACs	USWG handbook
http://eospso.gsfc.nasa.gov/	EOS Proj Sci Office	
http://eospso.gsfc.nasa.gov/directory/iwg/list.html	EOS Proj Sci Off	IWG Working Groups
http://eospso.gsfc.nasa.gov/eos_homepage/calendar.html	EOS Proj Sci Off	calendar
http://eosweb.larc.nasa.gov/	ESDIS	NASA Langley atmospheric sciences data center
http://esdis.gsfc.nasa.gov/	ESDIS	EOS System Management and Engineering Site
http://esdis.gsfc.nasa.gov/DSM/dsm.html	ESDIS	EOS DSM homepage

http://esdis.gsfc.nasa.gov/ad d/ad.htm	EGS ICWG	the EOSDIS architecture diagram and related pages with descriptions
http://esdis.gsfc.nasa.gov/ad d/instr.htm	EGS ICWG	EOS Instruments
http://esdis.gsfc.nasa.gov/ad d/sc.htm	EGS ICWG	EOS Spacecraft
http://essp.gsfc.nasa.gov/	GSFC Code 408	Earth Science System Pathfinder Project homepage
http://fpd.gsfc.nasa.gov/proj ects.html	NASA	NASA Flight Projects (can get to launch schedule)
http://gcmd.gsfc.nasa.gov/	GSFC Code 902	Global Change Master Directory (GCMD)
http://gcrio.gcrio.org:80/	GCRIO	US Global Change Research Information Office at CIESIN at Columbia U
http://geo.arc.nasa.gov/sge/l andsat/landsat.html	Landsat	Landsat program page
http://geochange.er.usgs.go v/	ESDIS	USGS Global Change Research Program
http://ghrc.msfc.nasa.gov/	ESDIS	Global Hydroology Center
http://globe.gsfc.nasa.gov/cg i-bin/home.cgi	GLOBE	education page, at GSFC and NOAA
http://harp.gsfc.nasa.gov/v0i ms/		Earth Science data search and order
http://harp.gsfc.nasa.gov/~i mswww/pub/imswelcome/	ESDIS	Earth Science data search and order
http://iree.gsfc.nasa.gov/ddts /	ESDIS	DRTT - Discrepancy Report Tracking Tool
http://ivanova.gsfc.nasa.gov/ daac/	ESDIS DAACs	DAACs map
http://ivanova.gsfc.nasa.gov/ hdfeos/workshop.html	ESDIS	HDF standards and tools
http://ivanova.gsfc.nasa.gov/ uswg/fliers/ed_fl.html	ESDIS	imformation fliers
http://ivanova.gsfc.nasa.gov/ ~stats/dacal.html	SOO	SCRS daily reports of the data processing
http://killians.gsfc.nasa.gov/e cog/web.htm	ECS	Combined outreach group to address common outreach concerns
http://listserv.gsfc.nasa.gov/ cgi-bin/admin	GSFC	majordomo@listserv site
http://ltpwww/MODIS/	MODIS	MODIS home page
http://ltpwww/MODIS/OPER ATIONS/SCFPOC.html	NASA	MODAPs POC list

http://m0mss01.ecs.nasa.gov/smc/	ECS	SMC
http://mcstweb.gsfc.nasa.gov/	NASA	MODIS Characterization Support Team
http://missionsystems.gsfc.nasa.gov/	EOS	EOS Mission Systems
http://mls.jpl.nasa.gov/	JPL	Mirowave Limb Sounder
http://nmp.jpl.nasa.gov/	JPL	New Millennium program
http://nodc.noaa.gov/	ESDIS	National Oceanographic Data Center
http://ntipalpha.atsc.allied.com/	CSOC	catalog search for CSOC
http://ntipalpha.atsc.allied.com/webpgs/acronym.htm	CSOC	acronym data base
http://observe.ivv.nasa.gov/	NASA	NASA Observatorium
http://podaac.jpl.nasa.gov/	ESDIS	Physical Oceanograhpy data center
http://proto.gsfc.nasa.gov/esdis/	ESDIS	ESDIS prototypes
http://radarsat.space.gc.ca/	Canada	Radarsat page
http://rsd.gsfc.nasa.gov/goes/	NOAA	GOES home page
http://seawifs.gsfc.nasa.gov/SEAWIFS.html	GSFC	SeaWiFS site
http://seawifs.gsfc.nasa.gov/SEAWIFS.html	EOSDIS	SeaWiFS home page
http://sedac.ciesin.org/	ESDIS	Socioeconomics Data and Applications Center
http://southport.jpl.nasa.gov/	NASA	Imaging Radar Home Page
http://spacelink.nasa.gov/.index.html	NASA	NASA Spacelink
http://spso.gsfc.nasa.gov/diss/	ESDIS	New DISS Homepage
http://spso.gsfc.nasa.gov/req/	ESDIS	ESDIS requirements home page
http://spsosun.gsfc.nasa.gov/ESDIShome.html	ESDIS	ESDIS Project home page
http://spsosun.gsfc.nasa.gov/Overview.html		Karen Whalen and Ted Meyer
http://spsosun.gsfc.nasa.gov/eosdata.html	EOS	EOS data products from SPSO
http://spsosun.gsfc.nasa.gov/spso/sdp/sdphomepage.html		Science Data Plan
http://thunder.msfc.nasa.gov/	MSFC	lightning and atmospheric research site

http://topex-www.jpl.nasa.gov/	EOSDIS	TOPES/POSEIDON Images and Data
http://trmm.gsfc.nasa.gov/	TRMM	TRMM
http://tycho.usno.navy.mil/	USNO	USNO time service
http://ulabibm.gsfc.nasa.gov/daacmgrs/	SOO	DAAC Status
http://ulabibm.gsfc.nasa.gov/~stats/charts/	SOO	SCRS Plots
http://ulabibm.gsfc.nasa.gov/~stats/dacal.html	SOO	DAAC Ops
http://ulabibm.gsfc.nasa.gov/~stats/eso.html	SOO	DAAC System/Science Operations
http://web.eos.ucar.edu/hirdls/	NCAR	HIRDLS page at NCAR
http://web.ngdc.noaa.gov/dmsp/dmsp.html	NOAA	Defense Meteorological s/c
http://www-airs.jpl.nasa.gov/	EOS	AIRS web site (atmospheric infrared sounder)
http://www-eosdis.ornl.gov/	ESDIS	site for biogeochemical dynamics
http://www-misr.jpl.nasa.gov/	NASA	MISR, Multi-angle Imaging SpectroRadiometer, web site at JPL
http://www-nsidc.colorado.edu/	ESDIS	National Snow and Ice Data Center
http://www-v0ims.gsfc.nasa.gov/v0ims/eosdis_home.html	ESDIS	EOS IMS home page
http://www.aerojet.com/Weapon_Systems/Earth_Sensing/AMSU/	EOS	AMSU page, PM-1 instrument
http://www.asf.alaska.edu/	ESDIS	ASF, Alaska SAR Facility
http://www.ciesin.org/TG/HDP/wcrp.html	CIESIN	World Climate Research Programme
http://www.cnrm.meteo.fr:8000/igbp/frame/acronyms/index.html	IGBP	IGBP-DIS accronyms
http://www.earth.nasa.gov/	ESE	Earth Science Enterprise
http://www.earth.nasa.gov/missions/spacecraft.html	ESE	Earth Observing spacecraft
http://www.earth.nasa.gov/nra/index.html	ESE	Earth Science Research Announcements
http://www.eoboard.co.uk/	Envisat	
http://www.fedstats.gov/	US Gov	One-stop shopping for federal statistics, Federal Interagency Council on Statistical Policy

http://www.gcrio.org/USGCRP/LaJolla/cover.html	EOS	LaJolla report of NRC
http://www.gcrio.org/educ/Welcome.html	EOS	Earth Education page
http://www.holonet.net/strategies/		Institute for Global Environmental Strategies, educators site
http://www.holonet.net/strategies/ADEOS.html	EOS	US site for ADEOS
http://www.hq.nasa.gov/office/codea/codeao/Welcome.html	NASA CIO	CIO homepage
http://www.hq.nasa.gov/office/legaff/	NASA	NASA Legislative news
http://www.ibm.com/IBM/year2000/	IBM	IBM Y2K page
http://www.jpl.nasa.gov/sespd/solar.html	JPL	ACRIM site
http://www.jsc.nasa.gov/somo/	SOMO	Space Operations Management Office
http://www.jsc.nasa.gov/somo/CSOC.html	NASA	
http://www.meto.umd.edu/~owen/EARTHCAST/	UofM	MARYLAND EARTHCAST is an educational service from U of MD
http://www.miningco.com/	MiningCo	Mining Company (data mining)
http://www.nap.edu/readingroom/enter2.cgi?0309064155.html	NAS	Report from BAS that sounds like Ghassem Asraf's presentation of more programmatic approach to atmos
http://www.nas.edu/	NAS	National Academy of Sciences
http://www.nasa.gov/nasa/nasa_subjects/nasa_subjectpage.html	NASA	This is an access point for NASA WWW information organized by subject.
http://www.ncar.ucar.edu/	EOSDIS	National Center for Atmospheric Research
http://www.noaa.gov/	EOS	NOAA
http://www.nodc.noaa.gov/	ESDIS	National Geophysical Data Center
http://www.omitron.com/eospm/eosfos/fos.htm	EOSDIS	PM-1 MOC Implementation Team home site
http://www.omitron.com/eospm/msrd.htm	NASA	MSRD - Mission System Requirements for PM-1 (documents site)
http://www.saa.noaa.gov/	ESDIS	Satellite Active Archive (SAA)
http://www.terraserver.microsoft.com/	EDC	Terraserver
http://www2.nas.edu/basc/	NAS	Board on Atmospheric Sciences of National Research Council of NAS

http://www2.nas.edu/besr/	NAS	Board on Earth Sciences and Resources of NAS
http://www2.nas.edu/besr/22 1a.html	NAS	Committee on Geophysical and Envirnmental data of BESR, group reviewing the DAACs
http://www2.nas.edu/besr/23 52.html	NAS	BESR review of the DAACs
http://www2.nas.edu/bsd/	NAS	Board on Sustainable Development
http://www2.nas.edu/nas/	NAS	NAS homepage
http://wwwghcc.msfc.nasa.g ov/AMSR/	MSFC	AMSR site

Appendix C
Anomaly Tracking, Reporting, and Resolution Procedure

C.1   Fault Isolation / Problem Resolution

The FOT is responsible for overall coordination of the troubleshooting effort for anomalies experienced in real-time. That is, when an anomaly occurs that affects either telemetry or command, the FOT will be responsible for notifying support elements of the problem and giving direction to space or ground network personnel to resolve the problem.

The SN COORD will be used by the FOT to coordinate TDRSS support fault isolation and resolution activities.

The GN COORD will be used by the FOT to coordinate EPGN support fault isolation and resolution activities.

Even though the FOT is responsible for coordinating anomaly isolation and resolution, all ground personnel should be constantly monitoring voice traffic over the appropriate SCAMA (SN for TDRSS & GN for EPGN problems) and monitoring data associated with each element during the troubleshooting process. In addition, any unexpected changes in ground configurations should be reported to the FOT immediately.

When a problem occurs, the FOT has three primary interfaces to help isolate the problems:

The space network: CSC at White Sands for TDRSS; WGS for EPGN
The Terra ground network: EDOS Operations
EPGN site: Link Controller at Wallops

C.2   Post-recovery troubleshooting

Space network problem troubleshooting: The FOT Operations Controller will be the point of contact for troubleshooting space network anomalies.

 Ground network problem troubleshooting: The EDOS operator is responsible for troubleshooting all ground network elements between EDOS and the ground station (whether it is White Sands or EPGN). This includes coordinating with the EDOS elements at White Sands and with Network personnel including the SNOM, GNOM, and NCC PA:

The NCC PA, providing around-the-clock support, will be responsible for contacting the COMM Mgr. or Tech Control if needed. The EDOS operator will be responsible for coordinating with the NCC PA to take action to solve a Terra ground system problem.

The SNOM, who is more cognizant of critical mission requirements, will be responsible for providing support during the critical mission periods (i.e. orbit raising, deployments, and early maneuvers) that use the TDRSS system. The EDOS operator will be responsible for coordinating with the SNOM to take action to solve a Terra ground system problem.

The GNOM, who is more cognizant of critical mission requirements, will be responsible for providing support during the critical mission periods that use the EPGN. The EDOS operator will be responsible for coordinating with the GNOM to take action to solve a Terra ground system problem.

Note

Additional details of Anomaly Tracking, Reporting, and Resolution Procedures are detailed in this MOSP at these locations:

- Space Network/ Network Control Center, Section 7.7
- EDOS, Section 5.5
- EPGS, Section 8.11
- NISN, Section 9.5

Appendix D

EOS Terra
Atlas/ Centaur
Acquisition Data Support Plan

Atlas/Centaur EOS Terra
Acquisition Data Support Plan

Section 1. Introduction

The Earth Observing System (EOS) Terra spacecraft will be launched from the Vandenburg Air Force Base (VAFB) Space Complex 3E (SLC-3E) onboard an AtlasIIAS/Centaur launch vehicle. The Tracking Data Relay Satellite System (TDRSS) and the EOS Polar Ground Network (EPGN) will support the EOS Terra mission. The supporting EPGN stations are Wallops Ground Station (WGS), Alaska Ground Station (AGS), and Svalbard Ground Station (SGS).

This mission consists of the following three phases: the launch phase, the ascent and early orbit phase, and the operational phase. The launch phase is defined as all activities from the beginning of the launch countdown through to Terra separation from the Centaur. The ascent and early orbit phase includes all activities during the first few weeks of the mission when several attitude and orbit adjustment maneuvers are planned. The operational phase is when the mission begins routine operations. Both the Multimission Flight Dynamics (MMFD) and the Terra Flight Dynamics System (FDS) will provide flight dynamics support. The FDS is located in the EOS Mission Operations Center (EMOC). The high level responsibilities for orbit determination, maneuver planning, and acquisition data support are summarized below in table 4-1.

	Orbit Determination	Maneuver Planning	Acquisition Data Support
Launch	N/A	N/A	MMFD
Ascent and early orbit	MMFD	FDS EOSMOC	FDS EOSMOC
Operational	On board	FDS EOSMOC	FDS EOSMOC

Table 1-1 Prime Support Elements

In addition, the MMFD will be a hot backup for acquisition data support during the ascent and early orbit phase. This means that the MMFD will be on hand during all maneuvers and be prepared to perform prime support if needed.

The purpose of this document is to address acquisition data support. This document will provide a support plan for the launch phase, which will include primarily acquisition data support of the launch vehicle. In addition, general information regarding acquisition data requirements during the ascent and

early orbit and operational phases are provided as guidelines for the development of detailed acquisition data support procedures for the FDS in the EOS MOC. Section 2 of this document will address acquisition data in general for the TDRSS Network and the EPGN. Section 3 will address MMFD acquisition data support of the launch and section 4 and section 5 will provide general guidelines for acquisition data support during the ascent and early orbit and operational phase. Section 6 will address contingency support.

Section 2. General Rules for Acquisition Data

2.1 SN Acquisition Data

The SN will support the Atlas/Centaur during the launch phase and the EOS/Terra spacecraft during all phases. TDRSS will utilize the TDRS single access (SA) gimbal antennas. TDRS acquisition of the target requires that the SA antenna maintain view of the target within a narrow beam. Commands to drive the SA antenna are generated at the TDRSS ground terminals located at the White Sands Complex (WSC). These commands are derived from the computation of position and velocity components based on target and TDRS state vectors. There are no autotracking capabilities to aid with acquisition and S-band commands must be continuously sent to TDRS to point the SA antenna to the target. In general, TDRS pointing error of greater than 0.86 degrees will equate to a loss of 3 db signal strength. Therefore, to maintain quality of TDRS-relayed data, the antenna must maintain view of the target within this narrow beam. To insure successful tracking and acquisition and minimize total error in pointing, it is desirable to reduce the target ephemeris error to much less than 0.86 degree.   In addition, the "Performance Specification for Services via the Tracking Data Relay Satellite System, S-805-1" (often referred to as the TDRSS Users Guide) states that the epoch deterioration of the user state vectors must be less than 9 seconds. Assuming that the target is directly under the TDRS, the worst case scenario where the along track error most effects the beam angle error, a 9 second error for a low-Earth orbit would result in an approximate beam angle error of 0.1 degree.   For low Earth orbits, a 9-second ephemeris error would results in approximately 75 kms error in position. Therefore, the total ephemeris error for Terra will be no larger than 75 kms.

State vectors and vector sequences are transmitted from the Network Control Center (NCC) to the two TDRSS ground terminals at White Sands Complex. State vectors transmitted to the NCC from supporting elements must be in the Improved Interrange Vector (IIRV) format defined by the STDN 724 and must be in the Greenwich Rotating Coordinates (GRC) reference frame. Within this format, there is a parameter that is used to identify the state vector by Type. On-orbit or free flight state vectors are labeled as Type 1 vectors, ignition states are labeled as a Type 4, and maneuver cutoff states are labeled as Type 5. A stationary vector is labeled as a Type 8 (no velocity relative to the earth). Depending on the vector type or the sequence of vectors, the software at the WSC will react differently in the building of the target ephemeris needed to support the TDRS-to-target tracking. Type 1 vectors will be propagated no more than 12 hours from its epoch. For maneuver sequences, several Type 7 vectors with a Type 2, indicating a transition from powered flight to a free flight state must be contained in a maneuver sequence for proper processing at WSC. A detailed explanation of proper vector sequences and processing ground rules are provided in Appendix D of the   "STGT Phase II Requirement Specifications', dated December 15, 1987. Typically, all on-orbit TDRSS users require Type 1 vectors for support except during a significant orbit adjust maneuver. In that event, sets of vectors or a maneuver sequence may be required to maintain good antenna pointing.

A significant enhancement has been implemented in vector processing software at WSC within the last few years. This enhancement now allows support of significantly large burns with the ignition state vector labeled as a Type 8 (having velocity components) and the cutoff state vector labeled as a Type 1. This essentially supports the burn with only two vectors thus eliminating the need to support a burn with a cumbersome maneuver sequence. The software at WSC will perform an interpolation of the position and velocity components from the ignition to the cutoff. WSC software will then propagate from the cutoff state until end of the tracking event since the cutoff state vector is a Type 1. For very large burns, comparisons between the two modes of support (maneuver sequence versus Type8/Type1 combination) have been shown to result in very little difference in antenna pointing (refer to CSC Memo 55733-04, by Dr. J. Cappellari, dated 11/4/94.). Several large Centaur burns, some as large as 6 minutes and resulting in an orbit change from a low Earth orbit to a highly elliptical orbit, have been successfully supported with a Type 8 and Type 1 vector. The FDS EOSMOC system can only provide Type 1 vectors to the NCC which will be sufficient for the size of maneuvers nominally planned for Terra. In the event of a contingency in which the predicted post burn vectors compared with the pre burn vector result in a difference of 75 kms or larger, the SN acquisition data for support through the burn will be generated and transmitted from the MMFD.

For daily on-orbit support, WSC requires Type 1 vectors with epochs at 4-hour centers. This is because WSC software will not allow on-orbit free flight vectors to be propagated more than 12 hours from epoch. This means that several Type1 vectors will be required by WSC daily. Typically, Flight Dynamics updates the NCC with vectors on Mondays, Wednesdays and Fridays with each delivery overlapping a full day with the next delivery. The NCC will in turn make daily transmissions to the WSC. These consist of Type 1 vectors with epochs at 4-hour centers over a 48-hour period. The overlapping of the vectors during daily transmission will insure that vectors for processing are resident at WSC in the event that a daily transmission is unsuccessful whereas vectors with duplicate epochs are overwritten. In addition, the most recently received vector will be used from its epoch forward and previously received vectors with later epochs will not be used following receipt of a new vector with an earlier epoch. Therefore, if vectors resident at WSC no longer represent the predicted state of the target, vectors with earlier epoch, but have epochs no earlier than 12 hours from transmission time, can be transmitted to WSC to delete earlier transmitted vectors. This scenario would be typically used in the event that a small maneuver was not supported with a maneuver sequence or Type 8 and Type 1, but subsequent post-maneuver data indicates that the target's actual state is diverging from the pre-maneuver state. In this scenario, updated post-maneuver state vectors would be transmitted to overwrite the pre-maneuver state vectors resident at WSC.

2.2 EPGN Acquisition Data

The EPGN, consisting of the WGS, AGS, and SGS stations, will utilize 11 meter az-el, S-band tracking antennas. The Wallops Orbital Tracking Information System (WOTIS) is responsible for scheduling and generating local pointing angles for the EPGN. Terra vectors will be provided to WOTIS from the FDS in the EOS MOC or by the MMFD from the Flight Dynamics Facility (FDF). In order to insure acquisition, it is desirable to have an antenna-pointing error less than 0.1 degree for the 11-meter EPGN systems. Therefore, for a 90-degree elevation Terra pass, the ephemeris error should be less than 2 kms for acquisition at horizon break.

It is planned that the EPGN network stations will eventually operate completely unmanned and fully automated. None of the stations are as yet ready to operate in automated mode so for the EOS Terra mission, operators will be present for launch.

For the launch phase of this mission, the MMFD will provide state vectors to WOTIS using FTP. FDS will perform this function during the ascent and early orbit and operational phase.

2.3 Ground Network (GN) Acquisition Data

In addition to WGS, AGS, and SGS, several C-band radars may be requested for support during any phase of the mission. It is desirable to have antenna pointing error less than 0.05 degree for C-band radar support. Acquisition data for radar support is provided in the form of Interrange Vectors (IRVs) and is transmitted via TTY circuits to the appropriate routers.

In the event that C-band radar support is requested, acquisition data TTY messages will be provided by the MMFD based on orbit information supplied to the MMFD from the FDS in the MOC. If required, acquisition data to the C-band radars will be generated and transmitted prior to launch support. The sites will also be updated in real-time based on the actual post-separation data that is received and processed by the MMFD.

Section 3. Launch Phase

3.1 General

MMFD shall be responsible for generating acquisition data for TDRS and Ground Networks for the launch phase (begin of launch count through Terra separation). During this phase, Terra acquisition data support is primarily for the launch vehicle. Though once the spacecraft fairings have been jettisoned, TDRSS will also be able to track the EOS Terra spacecraft using another SA antenna and will do so beginning at approximately L + 7 minutes. Terra acquisition data will utilize the 1873/01 SIC/VIC combination while the Atlas/Centaur launch vehicle will use 3332/02.

In addition to Centaur telemetry data being provided to the Atlas/Centaur support facilities, Centaur inertial guidance (CIG) data will also be transmitted to MMFD for processing state vectors. Air Force ground-based trackers will also provide support during launch with Onizuka Air Station (OAS) responsible for providing the Air Force ground-based tracker acquisition data.

TDRSS acquisition data will be generated and provided by the MMFD during the launch phase. All data transmitted from the MMFD to the Network Control Center (NCC) for TDRSS Centaur and TDRS Terra acquisition support will be contained in NISN IP-encapsulated 4800 bit block and transmitted through the standard NISN MMFD/NCC interface.

The mark events for the Atlas/Centaur Terra launch are listed below. Vectors and vector sets must be generated in the MMFD for transmission to NCC/WSC, which will be used to generate target ephemeris for the coast and powered flight phases of the launch to transfer orbit.

MARK EVENTS	TIME (seconds from

	liftoff)
Atlas Booster Engine Cutoff	166.047
Centaur Payload Fairing Jettison	191.047
Atlas Sustainer Engine Cutoff	281.600
Atlas/Centaur separation	283.507
Centaur first main engine start (MES1)	300.107
Centaur first main engine cutoff (MECO1)	669.433
Centaur/Terra separation	819.427
Centaur hydrazine depletion burn	3351.040

Table 3-1 Atlas/Centaur Mark Events

3.2 SN Premission Acquisition Data

Acquisition data for TDRSS support of the launch phase will be generated from nominal trajectory data provided by Lockheed Martin Aeronautics (LMA). The trajectory data will be provided in the standard 80-12 format and include 3-sigma dispersion cases. The final tested and guaranteed (TAG) trajectory delivery will be provided to MMFD by L-45 days. A specific mission inclination is targeted for this mission which may result in varying trajectories over the launch window. Depending on the trajectory variability, several trajectory cases may be needed for generation of premission acquisition data.

Premission acquisition data will be generated and be resident at the NCC/ by launch minus one day to support TDRS events scheduled from the beginning of the launch count through to the end of Centaur first burn (MECO-1) and the subsequent coast phase. Post MECO-1 coast phase events will be supported in real-time (see section 3.4). . All vectors used for acquisition data will be transmitted to the NCC with a SIC/VIC of 3332/02 for events scheduled for Atlas/Centaur launch vehicle support and with a SIC/VIC of 1873/01 for events scheduled for Terra support.

Premission acquisition data will be generated from the nominal trajectory tape and consist of a stationary Type 8 vector for support of the prelaunch events (pad events) and a vector sequence (launch sequence). The launch sequence begin with a Type 4 vector corresponding to the Atlas SRB ignition and end with Type 5 vector corresponding to the Centaur first burn cutoff (MECO1). This will support the mission phase from liftoff to coast phase following MECO1. Unlike typical Atlas missions, EOS Terra does not need a second centaur burn event.

Backup support vectors, to be used in the event that transmission from the MMFD to the NCC or transmission from the NCC to WSC is not possible, will be generated and provided via facsimile to the NCC and WSC also by launch minus 24 hours. These backup support vectors will consist of the stationary Type 8 (launch pad coordinates) and several Type 8 vectors with velocity and Type 1 vectors modeling the Atlas boost and Centaur burns. See the discussion in section 2.1.

3.3 EPGN Premission Acquisition Data

Premission support will consist of the MMFD extracting the spacecraft separation state from the latest Atlas IIAS/EOS Terra trajectory provided by LMA and referred to in section 3.2. The data will be converted to a WOTIS compatible ASCII version of the IIRV message using the 1873/01 SIC/VIC. The epoch of the vector will be that of the nominal separation event referencing a GMT liftoff time. The

separation state will be provided to WOTIS by launch minus 7 days via ftp to the WOTIS workstation at Wallops.

3.3. SN Real-time Support

Once launch has occurred, the NCC will apply the appropriate delta-t to the launch sequences (Atlas/Centaur and Terra) and transmit the sequences to WSC. The MMFD personnel will also apply the appropriate delta-t to their database.

In addition to TDRSS support, Vandenburg Air Force Base (VAFB) ground-based trackers will be supporting the launch. The Western Range (WR) Computers will process data from the VAFB assets and provide Launch Trajectory Acquisition System (LTAS) data to the MMFD. This data will contain orbit information from liftoff until the end of VAFB ground-based tracker support (expected to be before Centaur/Terra separation). Once the launch vehicle is out of view of the VAFB ground-based trackers, TDRS-relayed data will be processed at VAFB. An Improved Interrange Vector (IIRV) with epoch of post Centaur/Terra separation will be faxed to the MMFD based on this TDRS-relayed telemetry.

The TDRS-relayed Centaur data (256kbps, I channel data) will also be transmitted directly from WSC to the MMFD throughout the period of TDRSS support. This data will be processed at the MMFD and the MMFD will extract a Centaur/Terra separation vector. A Goddard Orbital Parameters Message (GOPM) will be generated and provided to the Centaur Project and the FDS in the EOS MOC via fax and email. The separation vector will also be used to generate initial spacecraft acquisition data.

Following Centaur/Terra separation, the MMFD will provide an updated Type 1 vector to the NCC based on data received and processed in the MMFD as mention above. A Type 1 vector will be transmitted to the NCC/WSC within 10 minutes of spacecraft separation. This vector will be based on the TDRS-relayed 256 kbps (CIGs) data processed in the MMFD. Comparisons between the IIRV faxed to the MMFD from VAFB and the MMFD extracted separation vector from telemetry processing in the MMFD will be performed and any significant discrepancies will be discussed with the TDRSS Network Operations Manager (TDRSS NOM).

3.5 EPGN Real-time Support

The EPGN will not be looking to the EOS Terra spacecraft while still attached to the launch vehicle. Launch support of the EPGN will consist only of updating WOTIS in the event of a launch slip of more than 1 second occurs at any point prior to liftoff. Neither WOTIS nor the EPGN stations have the capability of time biasing resident data so if necessary, the spacecraft separation state will be time biased by the MMFD and redelivered to WOTIS.

The MMFD will receive and monitor the CIGs data and make a determination as to the best available data. Once a real-time separation state is selected and quality assured, it will then be processed and delivered to WOTIS as described in section 3.3.

Section 4 Ascent and Early Orbit Phase

4.1 General

The ascent and early orbit phase is defined as the period between Centaur/Terra separation and just prior to the mission beginning routine mission operations. During this period, several attitude and orbit adjust maneuvers will be performed. The number and magnitude of the maneuvers will vary depending of launch performance and success at maneuver targeting.

MMFD analysis shows that the change in position from burn ignition to burn cutoff for all planned maneuvers is not large enough to require the generation of launch sequences. Good antenna pointing for both the SN and EPGN can be maintained throughout burn events. Along track positional differences for the six planned maneuvers ranged from 0.5 km to 14 km, well below tolerance.

During the ascent and early orbit phase, maneuver planning and acquisition data generation and delivery will be the responsibility of the FDS in the EOS MOC. Orbit determination during the ascent and early orbit phase will be the responsibility of the MMFD. The MMFD will be a hot backup for providing acquisition data to the SN and EPGN in the event that the FDS is unable to do so or if requested. This means that the MMFD will staff during all orbit adjust maneuvers and monitor the status of each maneuver event while being prepared to support if necessary.

4.2 Routine On-orbit Support

During the ascent and early orbit phase, which may extend for several weeks, daily acquisition data will be provided to the NCC and ground trackers by the FDS in the EOS Terra MOC.

For the EPGN, acquisition data will be generated and transmitted to WOTIS by 1:30 PM on a daily basis, except on days when a maneuver is scheduled. The data will span 72 hours (96 hours on Fridays) with the first vector at 00:00:00Z on the following day. Vectors will be at 4-hour centers.

For the SN, acquisition data will be generated and transmitted to the NCC by 1:30 PM each day, 7 days a week, except on days when a maneuver is scheduled. The data will span 48 hours with the first vector at 00:00:00Z on the following day. Vectors will be at 4-hour centers.

For days when there is a maneuver scheduled, follow the maneuver procedures below (section 4.3).

4.3 Maneuver Support

Before each planned maneuver, the FDS personnel will generate acquisition data for the NCC by no later than 3 hours and 30 minutes prior to the scheduled maneuver. SN and EPGN acquisition data will be generated based on a predicted post-maneuver ephemeris received from the MMFD. The data will consist of IIRVs at 4-hour centers for the 48 hour span following the burnout of the maneuver. The data is to start at the first 4-hour center prior to burn time.

The FDS personnel will transmit the predicted post maneuver acquisition data ASAP once the maneuver is declared nominal.

Post maneuver support will include updated acquisition data (if necessary) based on a post maneuver tracking that the MMFD receives. The MMFD will FTP a post maneuver ephemeris to the FDS by Maneuver + 3 hours and 30 minutes. This ephemeris will be used for the generation of the post maneuver acquisition data. Once the acquisition data is quality assured, the decision will be made whether to update the ground stations with current data based whether a greater than three-second acquisition of signal (AOS) difference is noted for any given station between solutions. Post acquisition data will be sent, if needed, by maneuver + 4 hours.

If the event that the maneuver is declared non-nominal, FDS personnel will update post maneuver acquisition data for the SN and EPGN as soon as possible. The acquisition data will be based on post maneuver tracking data processed by the MMFD.

In the event that the maneuver is cancelled, FDS personnel will not generate a new set of acquisition data. The no-burn acquisition data already resident at the NCC and EPGN (see section 4.2) will continue to be used until the next scheduled update. A schedule of acquisition data transmits is outlined in table 4-1.

Mnvr - 00 03:30	Generate acquisition data based on predicted post-maneuver state
00 00:00	**Maneuver Ignition**
Mnvr + 00:10:00	**Maneuver Burnout**
ASAP	Declaration of Burn Status. Transmit acquisition data based on predicted post-maneuver state if burn declared nominal. No transmission if burn canceled or no-go.
Mnvr + 04:00:00	Transmit acquisition data based on all available post-maneuver tracking (3-hour solution).
Mnvr + TBD hours	Transmit acquisition data based on all available post-maneuver tracking on the next day.

Table 4-1 Maneuver Schedule

Section 5 Operational Phase

5.1 General

The operational phase will mark the onset of routine on-orbit operations where the FDS assumes responsibility for orbit determination in addition to maneuver planning and acquisition data. The marked differences between this phase and the ascent and early orbit phase will be that the orbit adjust maneuvers will be infrequent and the MMFD will only support if requested. The MMFD will not be on hand for any maneuvers. Support will be more or less identical to that described in section 4. .

5.2 Routine On-orbit Support

For the EPGN, acquisition data will be generated and transmitted to WOTIS by 1:30 PM daily. The data will span 48 hours with the first vector at 00:00:00Z on the following day. Vectors will be at 4-hour centers.

For the SN, acquisition data will be generated and transmitted to the NCC by 1:30 PM daily. The data will span 48 hours with the first vector at 00:00:00Z on the following day. Vectors will be at 4-hour centers.

For days when there is a maneuver scheduled, follow the maneuver procedures below (section 5.3).

5.3 Maneuver Support

Same as section 4.3 with the FDS assuming all responsibilities formerly assigned to the MMFD.

Section 6 Contingency Support

In the event that there is a launch anomaly or spacecraft emergency, MMFD will be prepared to provide all necessary acquisition data for various non-EOS Terra Network support (e.g., JPL or Air Force RADAR). The FDS will still be responsible for SN and EPGN support. Upon request, the MMFD will also provide SN and/or EPGN support if needed.